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# Aging of Nuclear Station Diesel Generators: Evaluation of Operating and Expert Experience

## Phase I Study

Prepared by K. R. Hoopingarner, J. W. Vause, D. A. Dingee, J. F. Nesbitt

**Pacific Northwest Laboratory**
Operated by
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**Prepared for**
**U.S. Nuclear Regulatory**
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II

# ABSTRACT

Pacific Northwest Laboratory evaluated operational and expert experience pertaining to the aging degradation of diesel generators in nuclear service. The research, sponsored by the U.S. Nuclear Regulatory Commission (NRC), identified and characterized the contribution of aging to emergency diesel generator failures.

This report, Volume I, reviews diesel-generator experience to identify the systems and components most subject to aging degradation and isolates the major causes of failure that may affect future operational readiness. Evaluations show that as plants age, the percent of aging-related failures increases and failure modes change. A compilation is presented of recommended corrective actions for the failures identified. This study also includes a review of current, relevant industry programs, research, and standards.

Volume II reports the results of an industry-wide workshop held on May 28 and 29, 1986 to discuss the technical issues associated with aging of nuclear service emergency diesel generators.

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# SUMMARY

The potential for aging[a] of diesel generators in commercial nuclear service was evaluated by Pacific Northwest Laboratory (PNL). This report covers the collection and the analysis of operating and expert experience with diesel generators in nuclear service. The work was sponsored by the U.S. Nuclear Regulatory Commission's (NRC's) Nuclear Plant Aging Research (NPAR) Program and is being conducted in two phases. The purpose of Phase I of the study, reported here, was to provide a technical basis for future research (Phase II) and to provide useful insights into the mechanisms of aging degradation for a system that can affect reactor safety.

## CHARACTERIZATION OF ENGINES AND SYSTEMS

More than 200 diesel generators of various models, by various manufacturers are in service as emergency diesel generators (EDG) at nuclear plants in the United States. The diesel models and types currently in use at nuclear plants, their major components, and their support systems are briefly identified in this report. The number of engines in nuclear service, represented by this report, are listed below by manufacturer:

| Manufacturer | Number in Service in Nuclear Industry |
|---|---|
| ALCO | 18 |
| Allis Chalmers | 3 |
| Caterpillar | 5 |
| Cooper Bessemer | 36 |
| Fairbanks Morse | 49 |
| Electro-Motive Division (G.M.) | 84 |
| Nordberg | 8 |
| Transamerica Delaval | 31 |
| Worthington | 4 |

The diesel generator is a complex, small power plant within a nuclear facility. Consequently, the system boundaries defined for diesel generators in this study include various systems and components within the main engine systems and ancillary support systems. The diesel generator boundaries include the following:

- engine structure
- drive train
- valve mechanisms
- starting system
- intake and exhaust system
- generator system
- switchgear system
- instruments and controls system
- structural components
- miscellaneous mechanical systems

---

(a) For the working definition of "aging", refer to Section 1.5 of this report and/or NUREG-1144.

- fuel system
- lubrication system
- miscellaneous electrical systems
- cooling system.

## AGING STRESSORS

Diesel-generator systems and components are exposed to aging stressors from the environment, from performance characteristics, and from operational practices. The following stressors were identified as most likely to cause aging degradation:

- vibration
  - inherent sensitivity to normal operational vibration
  - sensitivity caused by startup cycles
  - sensitivity caused by poorly designed and manufactured components
  - sensitivity caused by poor installation or maintenance practices

- inferior quality of component
  - poor quality control during manufacturing
  - poor quality control during assembly
  - poor design
  - poor application

- adverse environment
  - inherent sensitivity to normal operational environment
  - unanticipated adverse conditions
  - design deficiencies
  - installation errors

- human error(a)
  - lack of training
  - lack of adequate quality control
  - need for direct assigned personnel to diesel-generator operation and maintenance.

## OPERATING EXPERIENCE

A review of over 2000 failures associated with diesel-generator systems from 1965 through 1984 revealed that roughly half the failures appear to be caused by some form of aging degradation. Additionally, computer analyses indicated that as plant age increases, the percentage of failures due to aging degradation increase and the modes of failure change.

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(a) Although human factors may contribute to aging, such stressors are considered outside the scope of this study.

By generating computer-formulated matrices of components and failure causes, the following indications of aging problems and causes were identified. The resultant analysis shows the overall ranking of failure causes due to aging degradation:

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 27 |
| Poor manufacturing or construction quality control | 18 |
| Adverse environment: dust, humidity, chemicals, etc. | 17 |
| Unknown | 14 |
| Human error - maintenance | 9 |
| Maladjustment/misalignment | 6 |
| Poor design: wrong application or component | 5 |
| Other | 4 |

Examination of comments associated with the various failure causes revealed that fasteners vibrating loose and metal fatigue are major contributors to diesel-generator system failures. A review of the component/failure-cause matrices indicates that components in the instruments and controls system (including the governor, alarm system, control air system, and terminations), the cooling system pumps and piping, the fuel system injector pumps and engine piping, and the turbocharger are particularly sensitive to vibration-induced failure. These failures are very similar to problematic components identified in related studies (McClymont and McLagan 1982).

## EXPERT OPINION

Before thoroughly evaluating the nuclear failure database, the PNL NPAR team developed a matrix that correlates components with causes of diesel-generator failure. This matrix is based on expert opinion, primarily from non-nuclear experience. After an independent review of the nuclear failure databases, a comparison between expert and operational experiences was performed. The results of the comparison show a few differences between the projected component failures, derived from non-nuclear experience and nuclear failure history. This indicates that the components subject to failure are similar in non-nuclear and nuclear application; the difference in failure rates may be due to operational cycling, maintenance practices, testing requirements, and/or reporting practices.

## CONCLUSIONS

By evaluating operating experience and expert opinion, the review team identified diesel-generator systems and components susceptible to aging degradation mechanisms. Classifying the failure causes with the associated systems and components provides the basis for a computerized database. This analysis tool can indicate aging problems or identify performance trends.

The evaluations performed in this study suggest that aging occurs in diesel-generator systems. Although plant-specific data are needed to definitively investigate the complex failure mechanisms and long-term failure trends, general trends were revealed that provided realistic insights. These insights will direct future examinations of aging mechanisms to significant components that are most prone to aging and that affect system safety and operational readiness of aged diesel generators.

## RECOMMENDATIONS

This Phase I assessment of aging degradation results in the following preliminary recommendations for the operation and maintenance of diesel-generator systems by the licensees (see 6.2 for details):

- conduct an active trend analysis program
- develop a dedicated maintenance program
- develop an aggressive engineering design review/change program
- maintain and improve vendor/contractor communications with the owner.

The specific recommendations applicable to regulatory consideration or further development are:

- Diesel generators due to their general locations are not susceptible to radiation aging effects for any appropriate operating environment and should not be studied further for radiation aging concerns.

- The regulatory process should be started to change Regulatory Guides 1.6, 1.9, and 1.108 to meet current needs and to respond to the research results found in Phase I of this study.

  (a) It is recommended that consideration be given to combining these guides into one document.

  (b) The diesel generator fast start requirement and testing may be appropriately modified to reflect the aging stressors found in this research and the release by the NRC of Final Rule CFR 51:12502 (leak-before-break considerations).

  (c) The diesel generator start-run-cooldown for testing purposes should be addressed via these revised guides to reduce aging stressors. The guide may refer to technical specifications to avoid the problem of different manufacturers recommendations.

  (d) It is recommended that considerations be given to permitting component or subsystem qualification testing following maintenance or correction of a known specific failure or fault rather than the start and running of the entire diesel generator system. As a minimum, a slow start-run sequence should be permitted for such qualification testing.

- The cost, complexity, and availability limits of station personnel leads the licensees to favor simple replacement of aging related component failures rather than a modification or a new component qualification. Regulatory changes are recommended to permit industry sponsored generic equipment or upgraded component qualifications to be used in all equivalent plants and locations, using an easier regulatory-documentation process.

- The diesel generator aging research performed led to consideration of life extension regulatory needs in detail. A concept was developed that the original design, construction, qualification, and testing process that led to the FSAR, technical specifications, and the existing licensing basis is not easily adaptable to a regulatory basis for life extension. It is recommended that a more appropriate basis for life extension should be based upon plant modifications, aging failures/effects, the maintenance system and correction of defects, operation practice and management, and the plant record system wherein the certifying information should be documented.

## FUTURE WORK

Future diesel-generator aging research will be conducted by PNL as a continuation of the NPAR program strategy. Under this strategy, the operational data from diesel-generator components identified as problematic and susceptible to aging degradation will be examined in more depth so that specific recommendations can be made to mitigate the effects of aging degradation. The selected problematic components will undergo an in-depth review in accordance with the NPAR Phase II research plan in conjunction with and in coordination with other NRC programs.

The focus of the Phase II plan will be:

- aging, service wear and life extension safety assurance
- the technical aspects of diesel-generator assessment
- selected engineering studies of problems revealed in Phase I.

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# ACRONYMS

| | |
|---|---|
| ACHAM | Allis Chalmers |
| AEOD | Office for Analysis and Evaluation of Operational Data |
| ANSI | American National Standards Institute |
| ASME | American Society of Mechanical Engineers |
| BMEP | Brake mean effective pressure |
| BNL | Brookhaven National Laboratory |
| BTP | Branch technical positions |
| CAT | Caterpillar |
| CB | Cooper Bessemer |
| CFR | Code of Federal Regulations |
| CMTR | Certified Material Test Report |
| DEFAD | Diesel Engine Failure Data |
| DEMA | Diesel Engine Manufacturers' Association |
| EDG | Emergency diesel generator |
| EDGAD | Emergency diesel generator aging data |
| EDGCTS | Emergency diesel generator component tracking system |
| EMD | Electro-Motive Division of General Motors |
| EPRI | Electric Power Research Institute |
| EQ | Environmental qualification |
| ESF | Engineered safety feature |
| FM | Fairbanks Morse |
| GDC | General design criteria |
| GM | General Motors |
| IE | (Office of) Inspection and Enforcement |
| IEEE | Institute of Electrical and Electronics |
| INEL | Idaho National Engineering Laboratory |
| LER | Licensee Event Report |
| LOCA | Loss-of-coolant accident |
| LOOP | Loss of offsite power |
| M/S | Maintenance and Surveillance |
| NEMA | National Electrical Manufacturers Association |
| NORD | Nordberg |
| NPAR | Nuclear Plant Aging Research |
| NPE | Nuclear Power Experience |
| NPRDS | Nuclear Plant Reliability Data System |
| NRC | Nuclear Regulatory Commission |
| NRR | (Office of) Nuclear Reactor Regulation |
| OG | Owners Group |
| OP | Opposed piston |
| ORNL | Oak Ridge National Laboratory |
| PNL | Pacific Northwest Laboratory |
| PTC | Performance test code |
| RES | (Office of) Regulatory Research |
| RG | Regulatory Guide |
| SWRI | Southwest Research Institute |
| TDI | Transamerica Delaval, Inc. |
| TEMA | Tank Equipment Manufacturers Association |
| WORT | Worthington |

## 1.0 INTRODUCTION

Emergency diesel generators (EDG) at nuclear plants provide class 1 emergency (1E) standby power to support the operation of emergency safety and plant protection system loads. During loss of power to the emergency buses from the main generator or offsite sources, the EDG system must provide backup power to operate critical reactor safety equipment.

During the past 20 years, in compliance with regulatory requirements, information has been compiled regarding the performance of diesel generators used in emergency service at nuclear facilities. More recently, research, meetings, seminars, conferences, and professional information exchanges have focused on diesel-generator problems. However, a systematic examination of how aging[a] contributes to diesel-generator failures has not been addressed. Aging is an important consideration, since the diesel engine and its support systems are intended to have a design life the same as the life of the plant and must maintain a high degree of operational readiness for this time period under normal and transient conditions.

This report Volume I summarizes the first step in a complete aging assessment: the evaluation of operating experience and quantification of expert knowledge. In view of the complexity of diesel-generator systems, the PNL NPAR team decided to document a critical review of operating experience from an aging perspective that could become the basis for further interactions with engine manufacturers and operators. This report also provides the technical basis for establishing the direction and scope of future diesel-generator aging research.

Volume II reports the results of an industry-wide workshop held on May 28 and 29, 1986. Diesel generator experience from the participants viewpoint has been organized into corresponding issues, discussion and responses, proposed solutions and recommendations in Volume II.

### 1.1 THE NUCLEAR PLANT AGING RESEARCH PROGRAM

Since equipment aging can potentially reduce the capability of a nuclear plant to operate safely, the NRC's Office of Nuclear Regulatory Research, Division of Engineering Safety, Engineering Branch, has established a comprehensive research program intended to evaluate the effects of aging on selected safety related components, systems and support systems. This program, entitled Nuclear Plant Aging Research (NPAR), is designed to identify, evaluate, and mitigate aging problems of components. The NPAR program (NUREG-1144) is addressing how the aging process may change the safety margins of key components in safety-related systems and how aging degradation can initiate failures. Both normal plant operations and responses to off-normal transients are being addressed.

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[a] See Section 1.5 for the definition of "aging" used in this report.

The NPAR program goals established by the NRC are to:

- identify and characterize aging and service wear effects which, if unchecked, could cause degradation of structures, systems and components, and thereby impair plant safety
- identify methods for inspecting, providing surveillance, and monitoring, or for evaluating the residual life of structures, systems and components to assure timely detection of significant aging effects before an unsafe condition develops
- evaluate the effectiveness of storage, maintenance, repair, and replacement practices in mitigating the effects of aging and in diminishing the rate and extent of degradation caused by aging and service wear.

To accomplish these goals the NPAR program strategy, illustrated in Figure 1.1, is being followed. The major program steps are shown in circles and the bases to accomplish these activities are provided in the boxes. Program steps completed to date are shaded.

Diesel generators were selected for aging assessment based on 1) an evaluation of risk or safety importance associated with failure of the diesel generator to perform its designated function (Davis et al. 1985), 2) correlation of risk and aging trends (Davis et al. 1985), and 3) joint recommendations of several NRC offices, particularly Nuclear Reactor Regulation (NRR), Nuclear Regulatory Research (RES), Inspection and Enforcement (IE), and Analysis and Evaluation of Operational Data (AEOD).

Diesel generators occupy a unique position in the NPAR program. Although they are on the list of components to be addressed in NPAR aging investigations, diesel generators are complex systems: actually, small power plants. The diesel-generator system comprises the engine and the auxiliary and interfacing equipment, including the fuel, lube, air start, cooling, and electrical subsystems, and special components such as the turbocharger, governor, and generator. Several of these subsystems interact, which contributes to the complexity of diesel-generator aging evaluations. An additional complication is that many vendors and several diesel power systems contractors supply diesel-generator systems to the nuclear industry, each with several models, modifications, and applications in service.

## 1.2 RELATED RESEARCH

Standby diesel-generator reliability for nuclear facilities is a subject of study by both the NRC and industry. This section of the report reviews this ongoing research and in Section 1.2.3 places the PNL-NPAR study in perspective.

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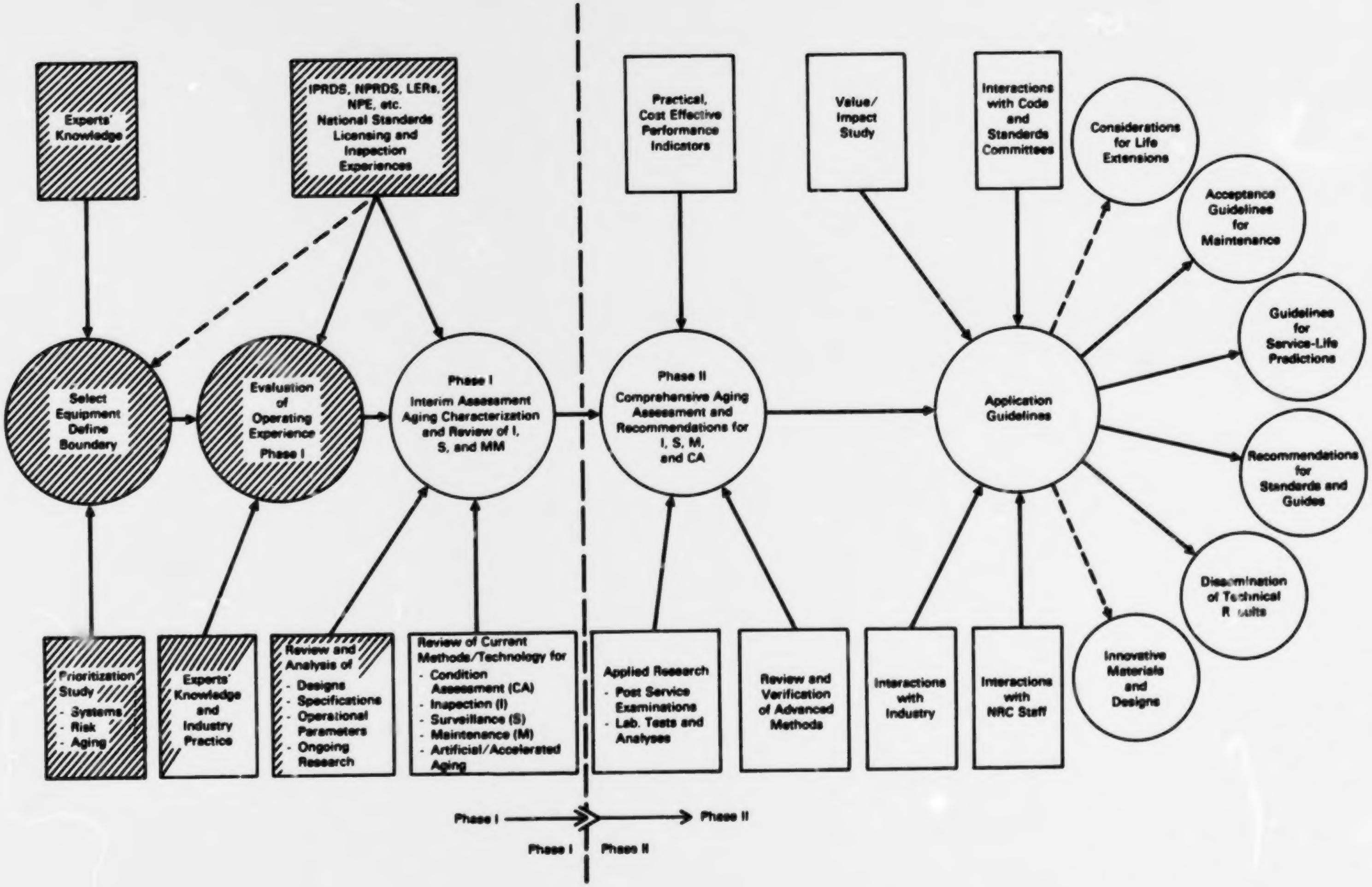
Experts' Knowledge
IPRDS, NPRDS, LERs, NPE, etc. National Standards Licensing and Inspection Experiences
Select Equipment Define Boundary
Evaluation of Operating Experience Phase I
Phase I Interim Assessment Aging Characterization and Review of I, S, and MM
Prioritization Study - Systems - Risk - Aging
Experts' Knowledge and Industry Practice
Review and Analysis of - Designs - Specifications - Operational Parameters - Ongoing Research
Review of Current Methods/Technology for - Condition Assessment (CA) - Inspection (I) - Surveillance (S) - Maintenance (M) - Artificial/Accelerated Aging
Practical, Cost Effective Performance Indicators
Value/Impact Study
Interactions with Code and Standards Committees
Phase II Comprehensive Aging Assessment and Recommendations for I, S, M, and CA
Application Guidelines
Applied Research - Post Service Examinations - Lab. Tests and Analyses
Review and Verification of Advanced Methods
Interactions with Industry
Interactions with NRC Staff
Considerations for Life Extensions
Acceptance Guidelines for Maintenance
Guidelines for Service-Life Predictions
Recommendations for Standards and Guides
Dissemination of Technical Results
Innovative Materials and Designs
Phase I
Phase II
Phase I
Phase II

FIGURE 1.1. NPAR Program Strategy

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### 1.2.1 NRC Studies

The following NRC offices are supporting research on nuclear standby diesel engines:

- Office of Analysis and Evaluation of Operational Data (AEOD)
- Office of Nuclear Reactor Regulation (NRR)
- Office of Inspection and Enforcement (IE)
- Office of Nuclear Regulatory Research (RES).

#### 1.2.1.1 Office for Analysis and Evaluation of Operational Data

The AEOD is supporting work at the Idaho National Engineering Laboratory (INEL) to develop a systematic approach to the analysis of data from the Nuclear Plant Reliability Data System (NPRDS). This development is focused on critical components of nuclear plants, one of which is the diesel generator. In this study INEL will evaluate the applicability of five methods of analyzing trends and patterns from the NPRDS: 1) survival analysis, 2) multiway tables and log linear modeling, 3) modeling of known reliability models to failure data, 4) trend analysis, and 5) detection of shifts in failure rates. INEL plans to review at least the following factors related to diesel engine performance: site, manufacturer, engine rotational speed, and load.

#### 1.2.1.2 Office of Nuclear Reactor Regulation

The NRR is engaged in a special project that involves a comprehensive evaluation of the reliability, operability, and quality assurance of Transamerica Delaval, Inc., (TDI) diesel engines. Questions concerning the TDI engines were raised because of a major failure in one TDI engine at the Shoreham nuclear power plant in August 1983, and other problems encountered with these engines in both nuclear and nonnuclear applications. With the support of PNL, the NRC has reviewed the technical efforts of the TDI Owners' Group (OG), comprised of the nuclear utility TDI engine owners. These OG efforts centered on 1) resolving problems with 16 components that were found to have potential generic problems and 2) confirming the design and quality of about 200 other key engine components. This NRC program developed maintenance and surveillance recommendations directed at assuring future reliable engine performance.

An NRR program at Brookhaven National Laboratory (BNL) is being conducted as part of Unresolved Generic Issue B-56, diesel-generator testing intervals. BNL is performing three tasks to address the issues:

- Sensitivity Analysis for Diesel-Generator Demand Test Intervals: determines the impact of various diesel reliability and outage parameters on maximum and optimal test intervals

- Diesel-Generator Data Acquisition: gathers diesel failure and repair data from utilities, with a specific goal of separating failures into those caused by standby and those caused by demand stresses

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- Diesel-Generator Safety Goals: analyzes plant emergency power systems to obtain diesel-generator availability goals consistent with core-melt safety goals.

The BNL analyses in support of these tasks have evaluated failure data according to whether the cause was due to prolonged engine standby status (e.g., leaking seals and gaskets, drift of relay set points), or stresses introduced by operation, such as vibration or wear-induced component failures. The optimum diesel-generator test interval is established by analyzing the repair time observed for each of these two failure classifications. BNL concluded that a reliability program that successfully monitors diesel component reliability without placing a demand on the diesel will lengthen test intervals and increase diesel availability. Monitoring for standby-caused failures and promptly repairing the problem and/or modifying the design to prevent the failure will improve diesel performance directly. Reducing demands and demand-induced stress will indirectly improve diesel performance. Examples include improving protective covers for relays in the starting and monitoring systems, air dryers and strainers in the air start systems, and lube oil recirculation systems that run when the diesel is shut down.

NRR also conducts special investigative studies of diesel engine failures as needed.

#### 1.2.1.3 Office of Inspection and Enforcement

The NRC IE Office has contracted with BNL to 1) review and evaluate results of an NRC/industry meeting on diesel engine reliability held in April 1985, 2) review industry responses to an NRR letter to utilities pertaining to possible changes in Regulatory Guide 1.108 (see Chapter 5.0), 3) evaluate Advisory Committee on Reactor Safety concerns regarding diesel generators, and 4) analyze the favorable diesel operating experiences of Japanese utilities. This work is in progress, so no final results are available.

#### 1.2.1.4 Office of Nuclear Regulatory Research

The NRC's RES is conducting the Nuclear Plant Aging Research (NPAR) program, for which this report meets the first milestone under the diesel-generator aging studies. RES is also sponsoring a pilot study to evaluate means of assuring diesel-generator reliability. That study, conducted by BNL, uses information from diesel-generator operations at the Trojan nuclear plant. The study is analyzing diesel failures and maintenance procedures in an effort to find correlations. The study will also review the results of monitoring operational engines for possible relationships with failures or corrective maintenance.

### 1.2.2 Industry Programs

Programs concerning nuclear plant diesel generators are being conducted by the utilities who own TDI engines and by the Electric Power Research Institute (EPRI).

### 1.2.2.1 TDI Owners' Group

Thirteen nuclear utilities who own TDI diesel engines have formed an owners' group to address concerns regarding TDI engine reliability and operability. The nature of their work is described in Section 1.2.1.2. About 30 reports have been written that deal with evaluations of 16 components having known, and potentially generic, problems. In addition, for each member utility, the TDI Owners Group has prepared a series of reports that address the design adequacy and quality of all components considered important to engine operability. The NRC's final evaluation of the Owners Group program is not yet available.

### 1.2.2.2 Electric Power Research Institute

EPRI has under way or has recently completed a number of studies of nuclear plant diesel generators. They are summarized in the following paragraphs.

Under contract to EPRI, Southwest Research Institute (SWRI) is reviewing all recorded Licensee Event Report (LER) failures. SWRI's findings will be used to formulate possible maintenance and surveillance programs for the diesel generators and to explore concepts for monitoring engine condition. SWRI plans to recommend hardware and software that may be used to diagnose problems and thereby improve engine reliability.

A recently completed study (Mollerus Eng. Corp. 1985) was made of failures of diesel generators at nuclear plants based on LER data from 1979 through early 1983. The objective was to identify failures in which surveillance testing was a contributing factor. Components were identified for which surveillance testing was a related factor: turbochargers, drive train and bearings, the starting system, the cooling system, the lube oil system, the governor, the exciter, and the voltage regulator. The most promising means of improving diesel-generator reliability appeared to be through improved maintenance programs.

EPRI is currently conducting a nationwide reliability analysis using direct operating data from all participating utilities (nearly 100% participation is expected). The focus of this study is to document actual reliability for use in station blackout studies.

As part of EPRI's life extension project, an overall review is under way of major components and systems at two nuclear plants, Monticello and Surry. The diesel generators at these plants have been selected for detailed study of forecasting deterioration (aging) modes and long-term behavior. The output of this program will be a decision model for inspection, replacement, and repair of the diesel generators. Considerations of vendor viability and mean time to resolve identified problems will be included. The type of diesel generator under study at the selected nuclear plants is manufactured by General Motor's (GM's) Electro-Motive Division (EMD).

EPRI also is conducting studies on emergency core-cooling requirements for boiling water reactor (BWR) and pressurized water reactor (PWR) nuclear plants.

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The purpose of these studies is to determine whether the NRC regulatory guidance concerning fast starts and engine loading is too restrictive.

Mollerus Engineering Corporation has completed a study for EPRI that evaluates Fairbanks Morse and General Motors EDGs (Mollerus Eng. 1985). The findings and conclusions of this study were based on an analysis of LERs from January 1978 through early 1983 and plant visits. The study concluded that improvements in diesel-generator reliability could be obtained with 1) comprehensive maintenance performed under a well-documented program, 2) improved training of maintenance personnel, 3) inter-utility communications, 4) coolant-water heating, 5) recalibration of engine-protection instrumentation at each refueling outage, and 6) continuous lubrication of engine main bearings and turbocharger bearings.

### 1.2.3 Discussion of Related Studies

The number and variety of studies by NRC and Industry suggest the significance of the EDGs in overall efforts to understand and improve the safety and reliability of nuclear plants. In general, the related studies 1) do not deal directly with aging issues and 2) do not include the active participation of diesel-generator experts. These are features of the PNL NPAR diesel-generator study. A conscious effort will be made to coordinate communication and avoid duplication with these related studies.

The NRC AEOD study is aimed at developing statistical methods of handling the NPRDS database, not at identifying and clarifying aging issues. The NRR special study concerning TDI diesel engines focused on problem resolution to requalify a particular manufacturers' engine. Aging was not specifically addressed. The NRR study pertaining to Unresolved Generic Issue B-56 indirectly addresses aging factors by means of "standby stressors." There is no direct consideration of aging mechanisms or condition monitors to detect aging.

The NRC-IE study pertaining to reliability and testing does not directly address aging mechanisms. Rather, it is aimed at documenting industry experience and special testing concerns. The NRC-RES study to correlate failure and maintenance will address condition monitoring in relation to failures, an issue which is of direct interest to the PNL-NPAR diesel generator program.

One of the studies done by industry, the life extension project, may have important but limited (to one diesel engine model) application to the PNL-NPAR study. The forecast deterioration modes and long-term behavior of the engines at the Monticello and Surry nuclear plants should be directly relevant.

PNL plans to review and use information developed in all of these ongoing and completed studies to avoid any duplication. When the studies developing maintenance and monitoring concepts have elements pertinent to aging, they will be assessed for use in the PNL-NPAR program. Examples of programs with good potential for generating relevant information are the BNL program for NRC-RES that will address fractures arising from standby stressors. Likewise the EPRI project on life extension should generate information useful to the PNL-NPAR diesel-generator project. Before completing the Phase II assessment, efforts will be made to coordinate and communicate with the researchers involved in these other studies so that the common elements can be incorporated into the PNL-NPAR studies.

## 1.3 SCOPE

Because of the depth and breadth of diesel-generator data, both operational experience and expert opinion were integrated to make a general assessment of aging related problems in diesel-engine systems. This was done to develop a usable expert diagnostic evaluation of the major failure processes associated with those systems.

### 1.3.1 Nuclear Operating Experience

The database used to evaluate diesel-generator operating experience related to aging was selected from the following four sources, chosen because of their level of detail and availability:[a]

1. licensee event reports (LERs)
2. the nuclear plant reliability data system (NPRDS)
3. nuclear power experience (NPE)
4. the TDI diesel-generator component tracking system.

Over 500 failure incidents from 1965 to 1984 were randomly sampled from each data source to form a database of over 2000 diesel-generator and related systems failure evaluations. The three diesel consultants and PNL staff members reviewed each incident to determine how aging may have caused the failures. After editing and removal of redundant events, 1,984 diesel-generator failures remain to characterize diesel generators.

### 1.3.2 Expert Opinion

The information used to develop expert experience was derived at a workshop at which three diesel consultants[b] and PNL staff members formulated a component/failure-cause matrix (see Chapter 4.0) to record the insights gained from extended diesel experience. This experience base represents an assessment of possible diesel-generator aging concerns that is independent of nuclear operating experience.

### 1.3.3 Other Information

Other sources of information were used to maintain a realistic perspective on the evaluation of operating and expert experience. This information included recommendations from various utility and vendor personnel associated with diesel-generator systems. Additionally, IE reports, related technical

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(a) Details concerning these data sources are presented in Section 3.2.
(b) Their resumes are presented in Appendix D.

publications, and an evaluation of applicable codes and standards were used to complete the aging evaluations. Current regulatory requirements are discussed in Chapter 5.0, because these pertain to aging considerations.

## 1.4 STRATEGY

In the early stages of the NPAR program, diesel generators were identified as a component essential to nuclear safety (Davis et al. 1985). Early identification of the boundaries of the diesel-generator system (addressed in Section 2.2) was performed because defined boundaries are fundamental to the scope of aging investigations.

The research conducted for this program is divided into two phases. Phase I efforts, reported here, establish the direction and scope of aging research by evaluating current diesel-generator experience. The results of Phase I studies can be used to identify the components most subject to aging, the preliminary mitigation measures, and the direction planned for Phase II research. During Phase I research, identifying the types of diesel engines and related systems was a major task due to the wide variations of engines and support systems in service at nuclear facilities. As a result, the research approach was directed at sampling a broad, but pertinent, database that could be examined at the level of depth necessary to isolate engine and system differences for aging analysis. Phase II research will focus on in-depth engineering studies of the problematic components and mechanisms identified during Phase I.

In view of the complexity of diesel generators, both in number of components and number of models in service, it was decided that this report would represent the Phase I Assessment (see Figure 1.1). Information developed by the PNL project team during Phase I provides an organized basis for subsequent review and interaction with users and vendors of diesel-generator equipment.

## 1.5 DEFINITIONS

For this report, the following definitions apply.

Aging[a] is the cumulative degradation occurring within a component, structure or system that, if unchecked, may result in loss of function and impairment of reliability. Factors causing aging include:

- natural internal chemical or physical processes
- external stressors and environment
- service wear, cyclic fatigue, vibration, etc.

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[a] It may be helpful to note that this aging definition is different from that in IEEE-323 and the words "may" and "will" are used for aging and abnormal aging respectively.

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In addition, "aging" may be induced by:

- testing
- improper installation, component application, operation and maintenance practices.

Abnormal aging is the cumulative degradation occurring within a component, structure, or system that, if unchecked, will result in loss of function and impairment of reliability.

Stressors are any combination of physical conditions and operating environment parameters that can cause system or component degradation.

The component/failure-cause matrix is a computer printout of systems and components showing the associated failure causes and frequencies.

The component/recommended corrective action matrix is a computer printout of systems and components showing the associated recommended corrective actions for all failures in the database.

The aging failure percentage is the percentage of aging-related failures in all failures.

## 1.6 REPORT CONTENTS

Chapter 2.0 describes the diesel-generator system boundaries, and the nine diesel generators and systems in nuclear service, Chapter 3.0 presents the operating experience evaluation, and Chapter 4.0 presents the expert opinion evaluation. Chapter 5.0 provides a discussion of current regulatory requirements, and Chapter 6.0 presents the conclusions and recommendations. The appendixes include a description of computer programs used, component analysis matrices, and consultant resumes. A list of information sources reviewed is included in the bibliography.

## 2.0 DIESEL ENGINES IN NUCLEAR SERVICE

With the exception of Oconee Units 1, 2 and 3 (which have two onsite 90 MW hydroelectric units), all operating domestic nuclear power plants have one or more diesel-generator sets installed to provide emergency power, as stipulated in 10 CFR 50. General Design Criterion 17, "Electric Power Systems," of 10 CFR 50's Appendix A, General Design Criteria for Nuclear Power Plants, requires that the onsite electric power system have sufficient capacity and capability to ensure that 1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences, and 2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents. To meet these requirements, a self-sufficient power plant (the diesel generator) must be ready to ensure emergency power availability.

## 2.1 EMERGENCY DIESEL-GENERATOR SYSTEMS

The emergency diesel generator in use at nuclear power plants is a composite of many systems, components, and auxiliary or ancillary systems. Each component must interface with other components in a system, and in some cases, through system boundaries and into other systems. Thus, the diesel-generator set is the focal point of many interactive system boundaries. A schematic of a diesel generator and its ancillary systems is presented in Figure 2.1, and a discussion of the auxiliary systems is included in this section.

### 2.1.1 Fuel Oil System

A fuel oil system typical of those used on some diesel-generator installations is shown in Figure 2.2. This system can include storage tanks; "day" tanks; drip tanks; transfer, feed, and booster pumps; nozzles; injectors; filters; valves; meters; strainers; piping; controls; and instrumentation.

The purpose of the fuel oil feed system is to provide an adequate reserve of fuel oil and to supply fuel oil automatically to the engine. The system is usually designed to meet operational requirements during emergency periods despite any single active or passive component failure.

### 2.1.2 Lubricating Oil System

The diesel-generator lubrication system is designed to provide adequate lubricating oil for engine lubrication and cooling. A schematic of a lube oil system typical of those used on nuclear diesel-generator installations is shown in Figure 2.3. These systems may include motor-driven pumps, engine-driven pumps, sump pumps, oil coolers, oil heaters, filters, strainers, valves, piping, controls, and instrumentation.

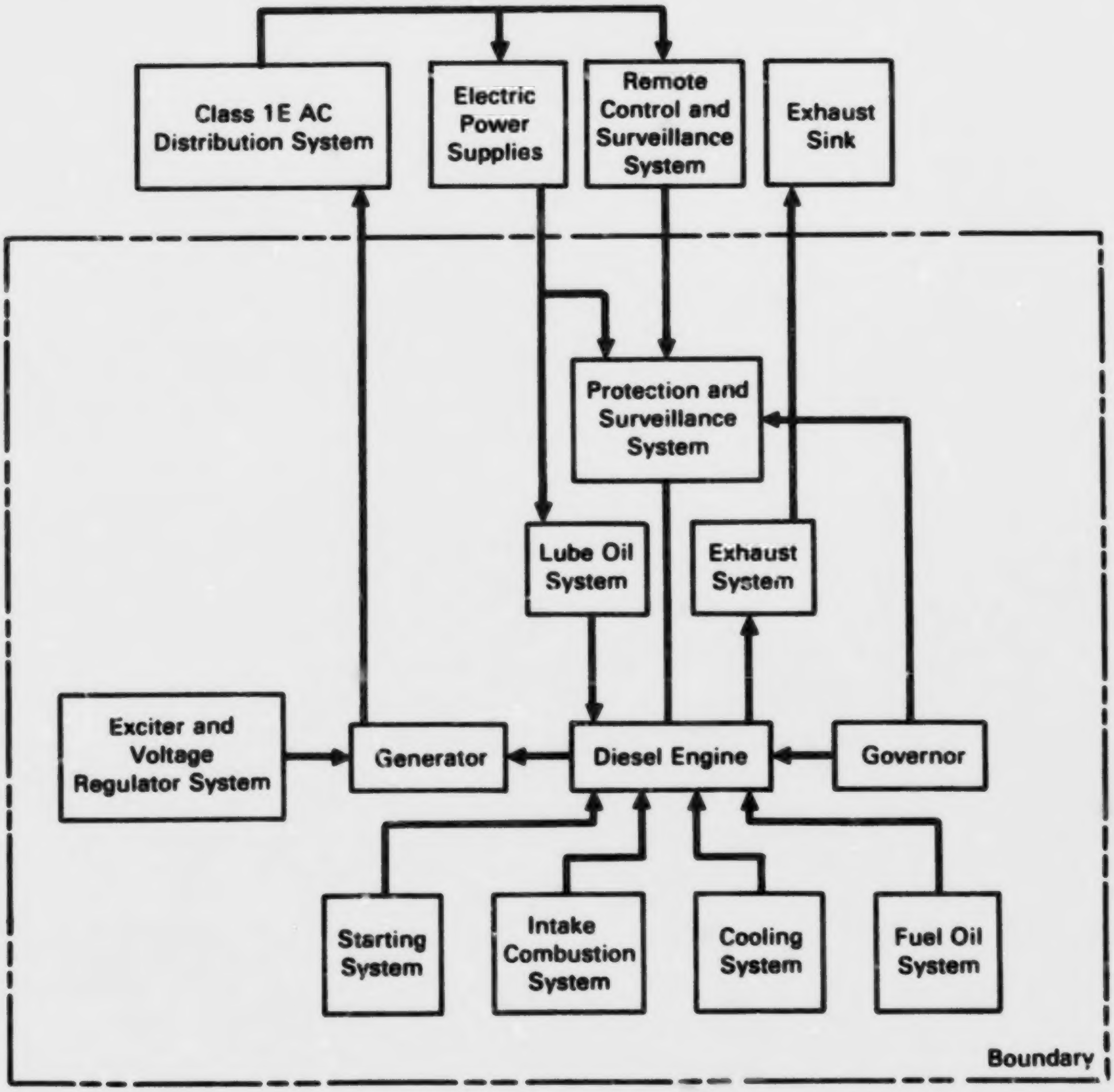
Class 1E AC Distribution System
Electric Power Supplies
Remote Control and Surveillance System
Exhaust Sink
Protection and Surveillance System
Lube Oil System
Exhaust System
Exciter and Voltage Regulator System
Generator
Diesel Engine
Governor
Starting System
Intake Combustion System
Cooling System
Fuel Oil System
Boundary

FIGURE 2.1. Boundaries of Diesel Engine System

### 2.1.3 Diesel-Generator Cooling System

The intent of the cooling system is to provide adequate cooling to diesel-generator systems and components. The coolant may be air or liquids, or a combination of the two. Liquid-cooled heat exchangers, radiators, or evaporative cooling towers may be used to dissipate heat and to control system temperatures. A one-line diagram of a diesel-generator cooling system is shown in Figure 2.4.

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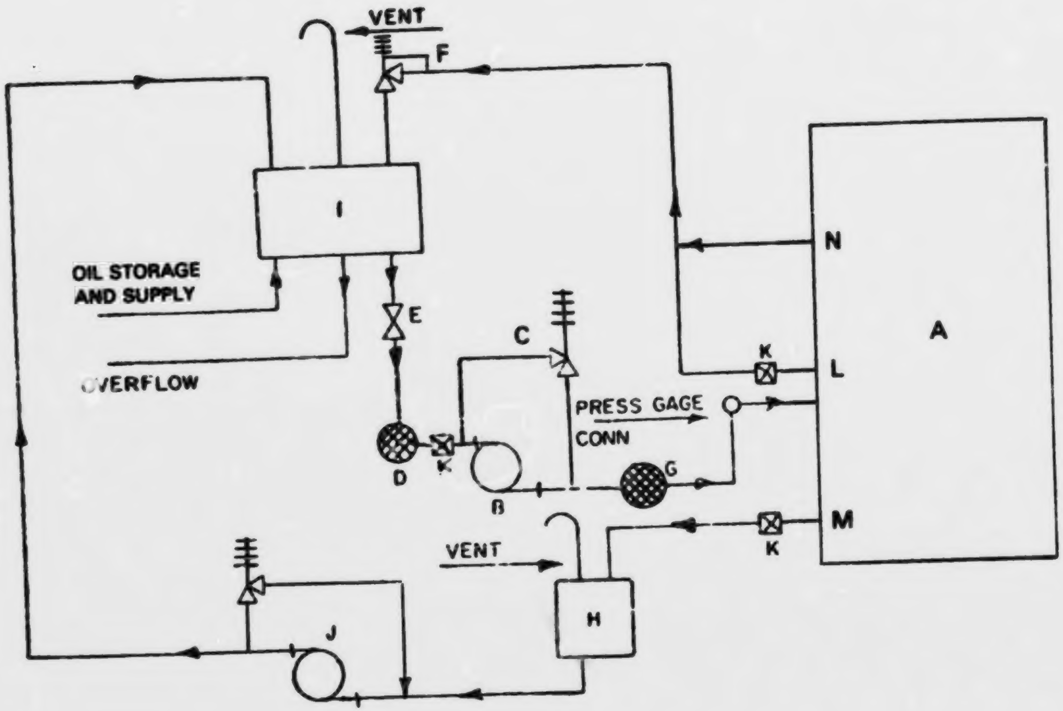
VENT
F
I
OIL STORAGE AND SUPPLY
OVERFLOW
E
C
PRESS GAGE CONN
D
K
B
G
N
K
L
A
M
K
VENT
H
J

| Letter | Name |
|---|---|
| A | Engine |
| B | Booster Pump-on Eng. |
| C | Relief Valve-on Eng. |
| D | Primary Filter |
| E | Globe Valve |
| F | Pressure Control Valve |
| G | Secondary Filter-on Eng. |
| H | Fuel Oil Drip Tank |
| I | Day Tank |
| J | Pump |
| K | Eng. Connections |
| L | Supply Header |
| M | Drip Header |
| N | Bypass Header |

FIGURE 2.2. Typical Fuel Oil System

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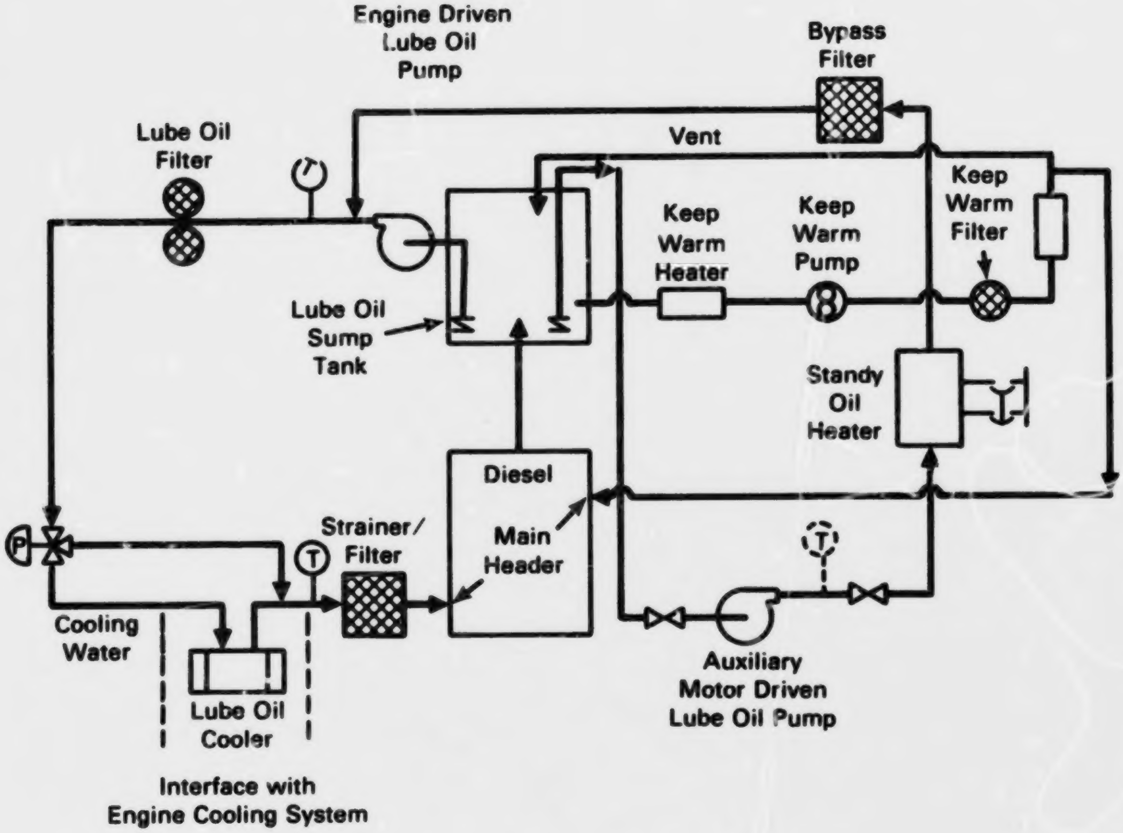
Engine Driven Lube Oil Pump
Bypass Filter
Lube Oil Filter
T
Vent
Keep Warm Heater
Keep Warm Pump
Keep Warm Filter
Lube Oil Sump Tank
Standy Oil Heater
Diesel
Main Header
Strainer/ Filter
T
P
T
Cooling Water
Lube Oil Cooler
Auxiliary Motor Driven Lube Oil Pump
Interface with Engine Cooling System

FIGURE 2.3. Lubricating Oil System

In addition to the coolers or heat exchangers, these systems may contain expansion tanks, piping, valves, controls, instrumentation, heaters, aftercoolers on the engine, circulating pumps, and engine-driven pumps.

### 2.1.4 Starting System

A starting air system typical of those on nuclear diesel installations is depicted in Figure 2.5. As shown, this system includes air motors; filters; strainers; controls; shutoff, relief, and pressure reducing valves; air compressors; air storage tanks; air coolers and dryers; piping; controls; and instrumentation.

The purpose of the starting air system is to provide a redundant supply of dry, compressed air to the diesel engine under all conditions. Usually this is accomplished by sequential injection of the air into each of the engine's cylinders.

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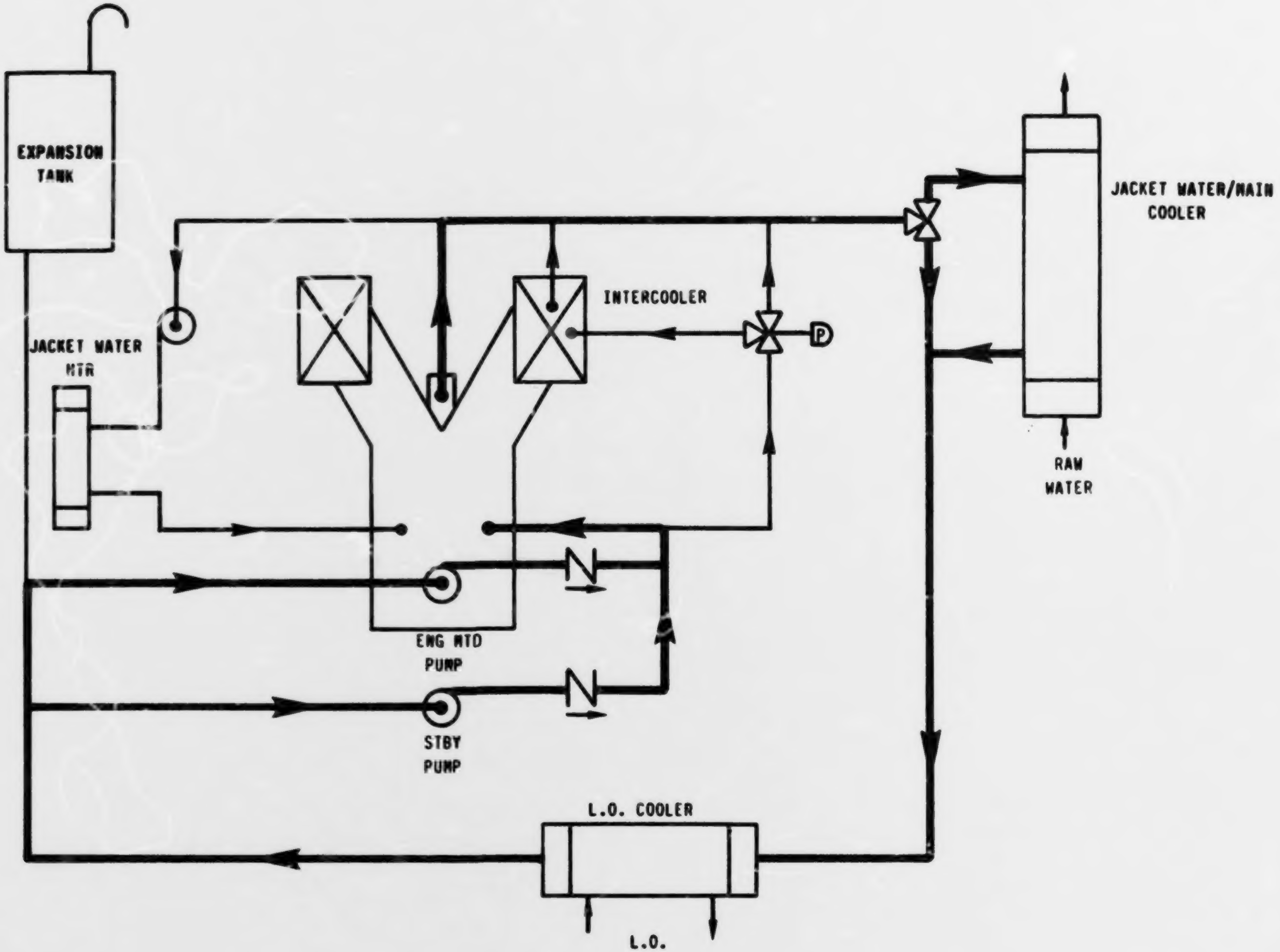
EXPANSION TANK
JACKET WATER HTR
INTERCOOLER
P
JACKET WATER/MAIN COOLER
RAW WATER
ENG MTD PUMP
STBY PUMP
L.O. COOLER
L.O.

FIGURE 2.4. Engine Cooling System

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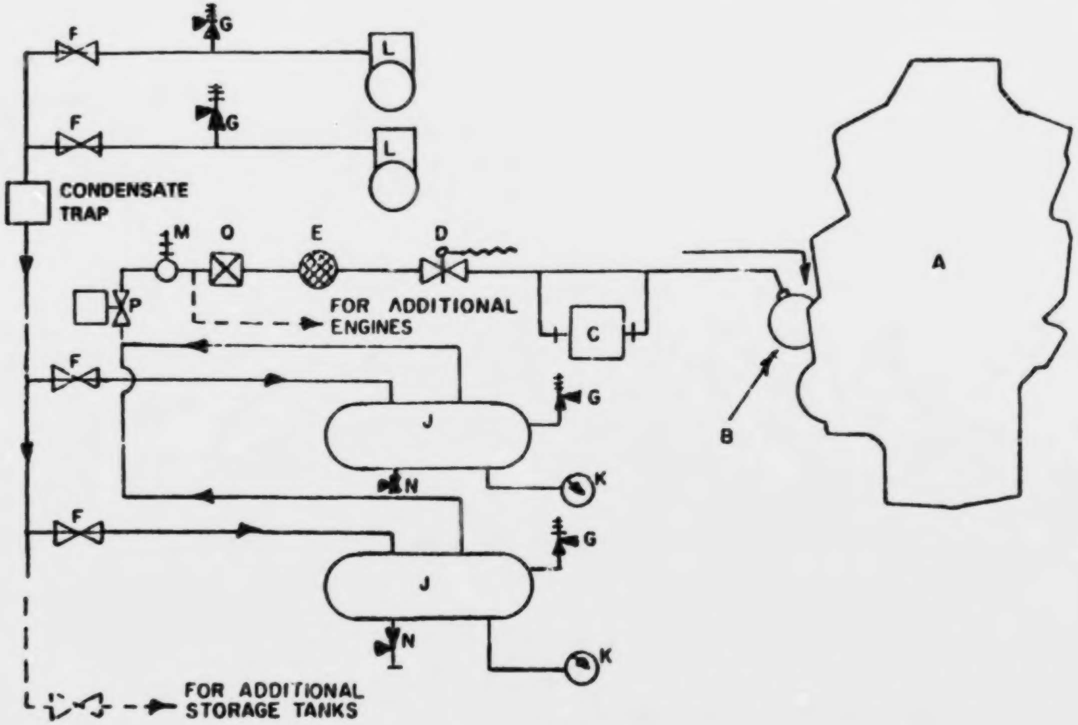
F
G
L
F
G
L
CONDENSATE TRAP
M
Q
E
D
P
FOR ADDITIONAL ENGINES
C
A
B
F
G
J
N
K
F
G
J
N
K
FOR ADDITIONAL STORAGE TANKS

| Letter | Name |
|---|---|
| A | Engine |
| B | Air Distributor on Eng. |
| C | Lubricator-on Eng. |
| D | Starting Valve |
| E | Strainer |
| F | Shut-off Valve |
| G | Relief Valve |
| J | Air Tank |
| K | Pressure Gage |
| L | Air Compressor |
| M | Pressure Reducing Valve |
| N | Drain Cock |
| P | Shut-off Valve |
| Q | Conn. to Eng. Sys. |

FIGURE 2.5. Starting Air System

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### 2.1.5 Intake and Exhaust Systems

The diesel-generator air-intake system is designed to provide adequate amounts of clean air to support the engine's combustion process. The diesel exhaust system must dissipate the hot gases to the outside environment. A schematic of a typical intake and exhaust system is shown in Figure 2.6.

### 2.1.6 Generator System

The generator system of a diesel generator in a nuclear plant includes the excitation and voltage regulating systems, the main leads, and at least a portion of the associated distribution system, in addition to the generator proper. Such a system is identified in Figure 2.1.

### 2.1.7 Instrumentation and Control Systems

Figure 2.1 shows the major interrelationships of the governor, control, switchgear, protection, and surveillance systems associated with the startup and operation of a diesel generator in nuclear service.

The diesel generators are designed to start automatically upon loss of offsite power to their respective buses, low reactor-water level, high containment pressure, or other emergency condition signals. The diesel generators have the capability to start and automatically pick up the required loads. The application of load is automatic and is determined by safe reactor shutdown requirements. The transfer of Engineered Safety Feature (ESF) buses from normal to standby supply is automatic.

Auxiliary motors and controls required to start the emergency diesel generator operate from separate station power or battery systems. Auxiliaries required to assure continual operation of the emergency diesel generator are supplied from the ESF buses or controlled power systems.

Diesel generators are generally capable of being started or stopped manually from local control stations near the engines and from remote stations, usually located in the reactor control room. Normally the generators can be connected to the ESF buses from the control room, but not locally at the engines. Audible and visual alarms and monitoring indicators are located in the control room and at the local control stations.

Components of these systems include breakers, relays, contacts, buses, batteries, invertors, chargers, rectifiers, transformers, relays, sensors, wiring and terminations, alarms, recorders, monitors, dials, gauges, valves, linkages, and governors.

## 2.2 DIESEL ENGINE MODELS

Over 200 diesel generators made by at least nine manufacturers are used at operating and planned nuclear plants in the United States. Table 2.1 provides

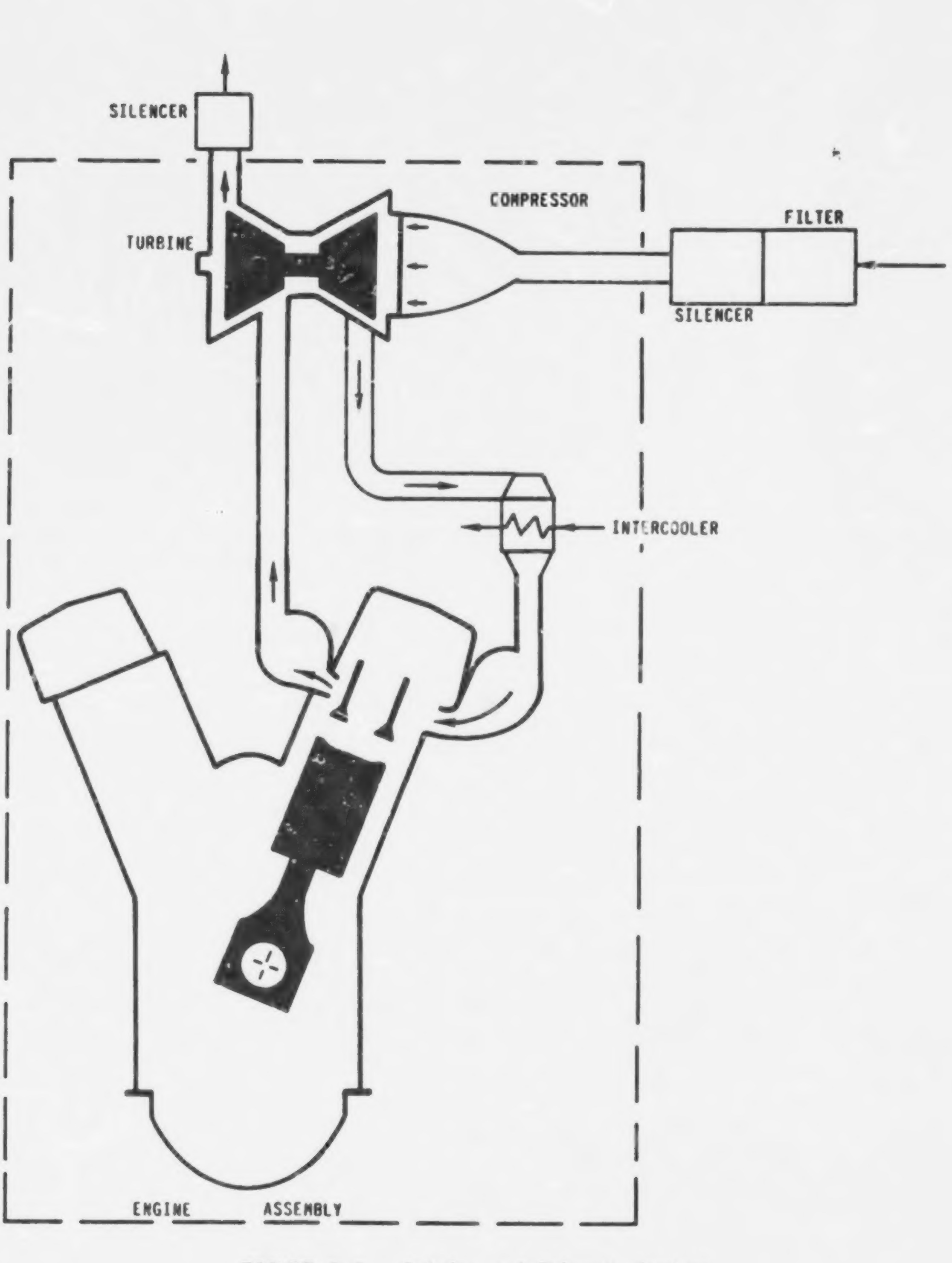
SILENCER
COMPRESSOR
FILTER
TURBINE
SILENCER
INTERCOOLER
ENGINE
ASSEMBLY

FIGURE 2.6. Intake and Exhaust System

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TABLE 2.1. Diesel Engines in Nuclear Service

| Manufacturer | Approximate Number in Service (1985) |
|---|---|
| ALCO | 18 |
| Allis Chalmers | 3 |
| Caterpillar | 5 |
| Cooper Bessemer | 36 |
| Fairbanks Morse | 49 |
| Electro-Motive Division | 84 |
| Nordberg | 8 |
| Transamerica Delaval | 31 |
| Worthington | 4 |

a tabulation of the known number of engines in nuclear service by manufacturer. There may be others. Several models from each manufacturer are used so that there are perhaps 15 to 20 different engine types in service. The following sections provide a general description of each manufacturer's engines, highlighting distinctive design features. The information supplied below was obtained from the engine manufacturers. As a result, the level of detail is not the same in all cases.

### 2.2.1 ALCO Power, Inc.

The ALCO Model 251 diesel engine is built by the ALCO Engine Division of White Industrial Power, Inc. This engine is a turbocharged,(a) medium-speed, four-stroke engine, with the pistons configured either in-line or in a vee-type arrangement, with a cylinder diameter of 9 in. and a stroke of 10.5 in. The engine is rated up to 220 hp-per-cylinder and operates with a brake mean effective pressure of about 280 psi. The engine operates at 720, 900, or 1200 rpm. When coupled with generators, it is rated from 500 to 2830 kW at 60 Hz.

ALCO 251 diesel engines for the Phase I study were shown at the nuclear power plants listed in Table 2.2.

TABLE 2.2. Nuclear Plants Using ALCO 251 Diesel Engines

| Utility | Facility |
|---|---|
| Power Authority of the State of N.Y. | Indian Point 1 and 2 |
| Public Service Electric and Gas Co. | Salem 1 and 2 |
| Consumers' Power Co. | Palisades |
| Boston Edison | Pilgrim 1 |
| Rochester Gas and Electric | Ginna |

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(a) The turbo-charger assembly is used to increase engine horsepower and provide better fuel economy by using the exhaust gas energy to compress the combustion air before injection into the firing chamber.

A cross section of the 16-VEE-251 engine from the drive end is shown in Figure 2.7.

The cylinder blocks and engine base are fabricated of welded steel plates and forgings. The crankshaft is made from forged steel and has hardened journals. The connecting rods have an I-type cross section. The ALCO engine incorporates two-piece pistons that are comprised of an aluminum body and a steel crown. The cylinder heads are made of an alloy steel and have two intake and two exhaust valves, each with stellite seat inserts. Cylinder liners are of cast iron with chromium plating, and are of the "wet-type" construction.(a) There is one turbocharger for each engine.

Engine starting is accomplished with an air-operated motor. Each cylinder has its own fuel injection pump. The lubricating oil and fuel oil boost pumps are engine driven.

### 2.2.2 Allis Chalmers

Allis Chalmers is a former manufacturer of diesel engines and diesel-generator sets of the size and capacity for use in nuclear power plants to provide onsite emergency power. Data on these diesel-generator units and their application are not readily available because the vendor no longer supplies engines to the nuclear industry.

Nuclear installations of Allis Chalmers diesels, for service as diesel generators, include at least three units in Dairyland Power Corporation's La Crosse facility in Wisconsin. It has been reported that each of these units is rated at 250 kW.

### 2.2.3 Caterpillar

Caterpillar manufactures a number of diesel-generator sets that are of the smaller size and capacity used in nuclear facilities to provide power for the engineered safety features (ESFs). These engines are turbocharged, four-cycle operation constructed in both in-line and vee piston configurations and range from 50 to about 500 kW.

Caterpillar diesels have been installed for emergency service in at least the nuclear plants listed in Table 2.3.

TABLE 2.3. Nuclear Plants Using Caterpillar Diesel Engines

| Utility | Facility |
|---|---|
| Consumer Power Co. | Big Rock Point |
| Dairyland Power Corp. | La Crosse |
| Public Service Co. of Colorado | Fort St. Vrain |

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(a) In the "wet-type" construction, cooling water touches the outer surface of the liner.

20

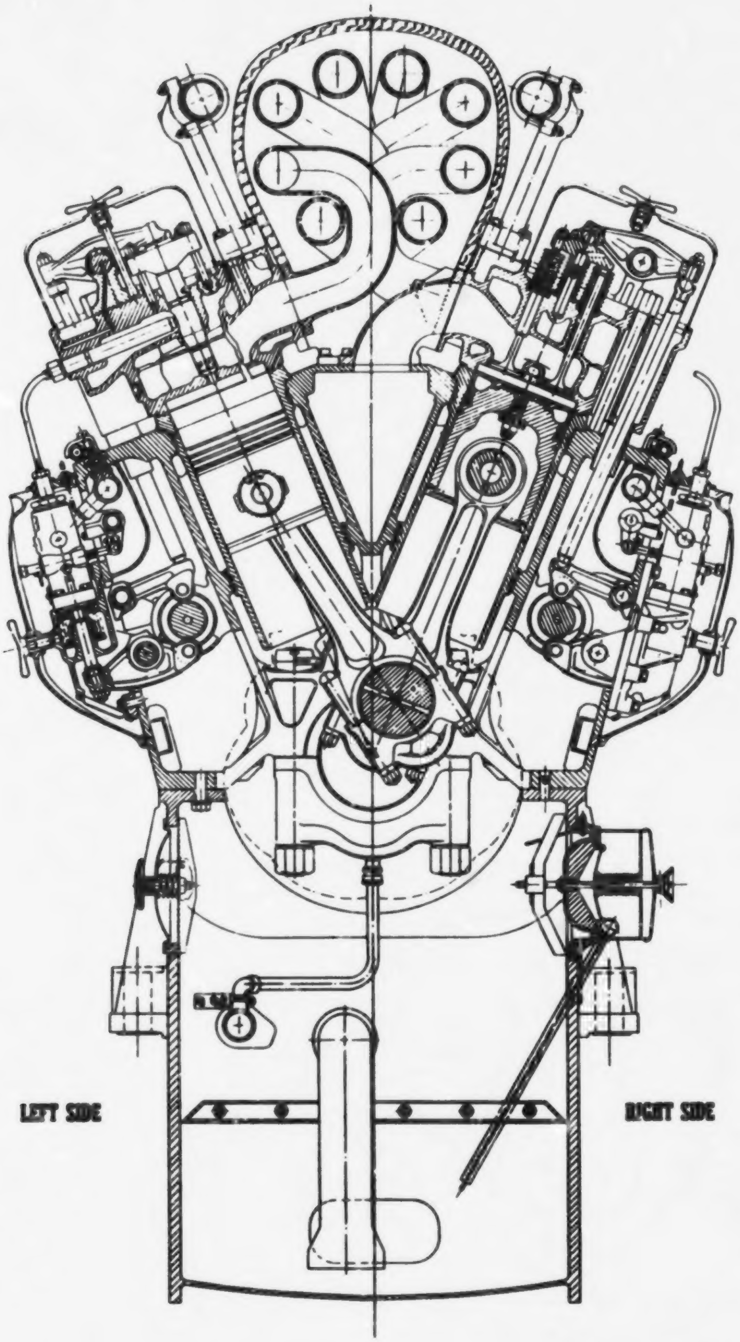
LEFT SIDE
RIGHT SIDE

FIGURE 2.7. Cross Section Through an ALCO 16-VEE-251 Engine Looking from Drive End

The CAT Model D398 engine, which is representative of the unit installed at La Crosse, has 12 cylinders in a vee arrangement; each piston has a 6.25 in. bore and an 8.0 in. stroke.

### 2.2.4 Cooper Industries

The Cooper-Bessemer KSV model engines are built by Cooper-Bessemer Reciprocating Division of Cooper Industries. These engines are turbocharged, four-cycle, of the vee configuration, and rated at 200 psi brake mean effective pressure (BMEP). The KSV model has a 13.5 in. bore, 16.5 in. stroke and it operates at 514 to 600 rpm. Each model is made with 12, 16, or 20 cylinders and is rated from 3450 to 8390 hp. A cross section of the KSV engine is shown in Figure 2.8.

Thirty-six Cooper-Bessemer diesel engines are known to be installed in the nuclear plants listed in Table 2.4.

The engine base is a one-piece fabricated steel structure that supports the engine, generator, and outboard bearing. A one-piece cast iron centerframe is bolted to the base and provides the support for the crankshaft. Two cylinder blocks, one for each bank, are secured to the top of the centerframe and contain wet-type liners in each cylinder.

The forged steel alloy crankshaft is underhung in the centerframe. The articulated connecting rods are high-strength steel forgings of the H-column design. Standard cast iron pistons are of a trunk-type design and oil cooled.

Cylinder heads feature a valve-in-head design with two inlet and two exhaust valves in each head. All exhaust gases are discharged into a large single-chamber manifold that feeds the constant-pressure turbochargers.

TABLE 2.4. Nuclear Plants Using Cooper-Bessemer Diesel Engines

| Utility | Facility |
|---|---|
| Pennsylvania Power and Light Co. | Susquehanna 1 and 2 |
| Commonwealth Edison Co. | Zion 1 and 2 |
| Nebraska Public Power District | Cooper |
| Louisiana Power and Light | Waterford 3 |
| Commonwealth Edison Co. | Byron 1 and 2 |
| Commonwealth Edison Co. | Braidwood 1 and 2 |
| Arizona Public Service | Palo Verde 1, 2, and 3 |
| Niagara Mohawk Power | Nine Mile Point 2 |
| Houston Lighting and Power | South Texas Project 1 |

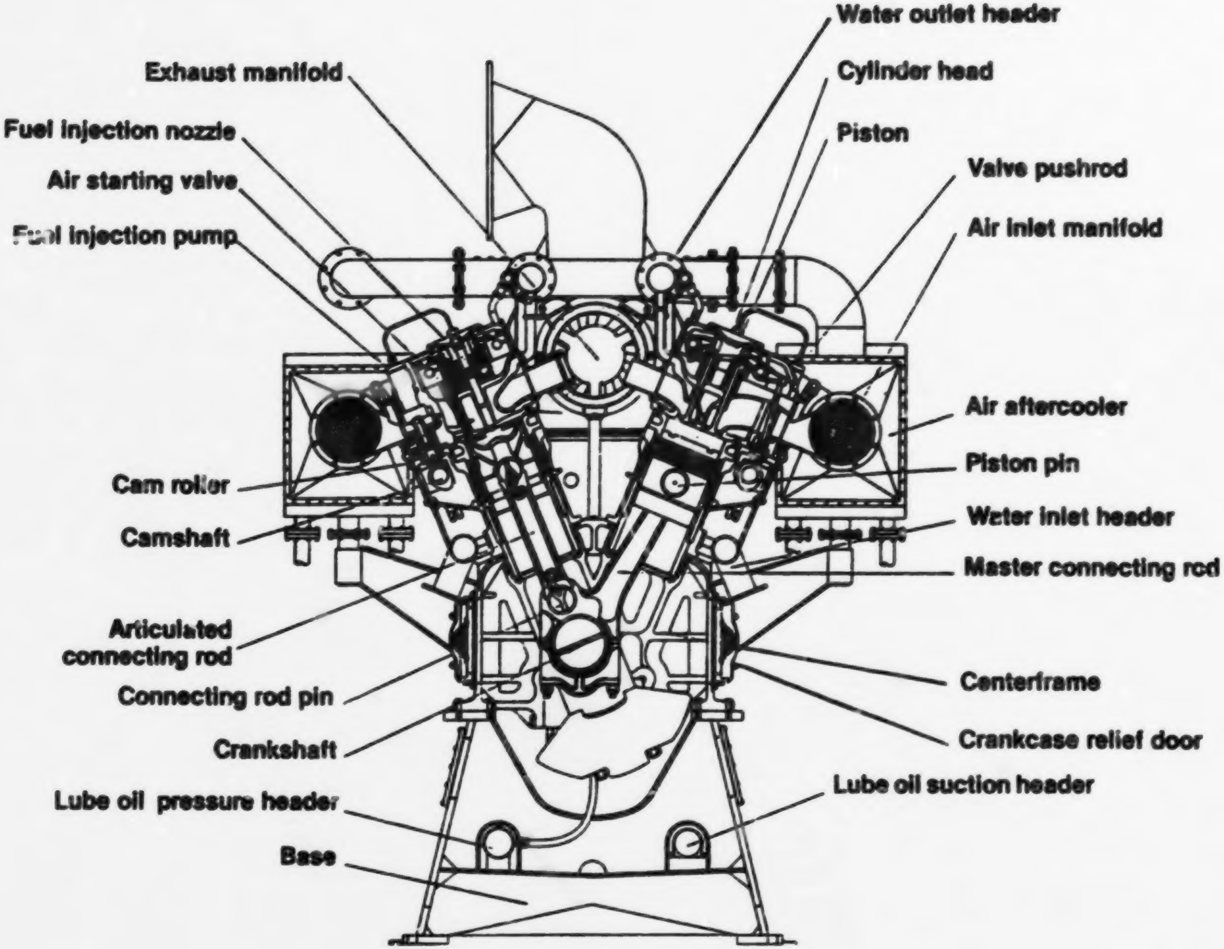
Water outlet header
Exhaust manifold
Cylinder head
Fuel injection nozzle
Piston
Valve pushrod
Air starting valve
Air inlet manifold
Fuel injection pump
Air aftercooler
Cam roller
Piston pin
Camshaft
Water inlet header
Master connecting rod
Articulated connecting rod
Connecting rod pin
Centerframe
Crankshaft
Crankcase relief door
Lube oil suction header
Lube oil pressure header
Base

FIGURE 2.8. Cooper-Bessemer KSV Engine Cross Section

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### 2.2.5 Fairbanks Morse

Fairbanks Morse and Colt-Pielstick diesels are made by the Fairbanks Morse Engine Division of Colt Industries. The FM 38TD8-1/8 diesel is a two-cycle or two-stroke opposed piston uniflow port, scavenged engine. The engine is rated to 350 hp per cylinder and operates at 900 rpm. The engine has a cylinder diameter of 8-1/8 in. and a stroke of 10 in. The brake mean effective pressure is 90 psi.

Nonturbocharged engines are made in 4, 5, 6, 8, 9, 10, and 12 cylinder models, while the turbocharged series such as the 38 TD 8-1/8 model is built in 8, 9, and 12 cylinder configurations. The turbocharged engines are rated from about 1200 kW to 3300 kW at 720 to 900 rpm.

Fairbanks Morse engines are used for EDG service at a number of nuclear facilities, as listed in Table 2.5.

A cross section cutaway view of a typical Fairbanks Morse opposed piston engine is depicted in Figure 2.9. The engine is constructed with an upper and lower crankshaft driven by opposed pistons. The cylinder block is a one-piece structural weldment that provides support for the crankshaft and other engine components and systems. The crankshafts are hollow and cast from ductile iron. The upper and lower crankshafts are connected via bevel gear drives and a vertical drive shaft. There is one cast iron cylinder liner for each pair of pistons. The pistons have a two-piece design; the crown and skirt are made of one-piece cast iron and have a piston pin carrier bolted inside. The drop-forged connecting rods are made of alloy steel. The engine does not have cylinder heads or valves.

TABLE 2.5. Nuclear Plants Using Fairbanks Morse Diesel Engines

| Utility | Facility |
|---|---|
| Alabama Power Co. | Farley 1 and 2 |
| Arkansas Power and Light | Arkansas Nuclear Two |
| Baltimore Gas and Electric Co. | Calvert Cliffs 1 and 2 |
| Carolina Power and Light Co. | Robinson 2 |
| Detroit Edison | Fermi 2 |
| Florida Power Corp. | Crystal River 3 |
| Georgia Power Co. | Hatch 1 and 2 |
| Iowa Electric Light and Power Co. | Arnold |
| Long Island Lighting Co. | Shoreham 1 |
| Metropolitan Edison Co. | Three Mile Island 1 and 2 |
| Northeast Utilities Services Co. | Millstone 1 and 2 |
| Northern States Power Co. | Prairie Island 1 and 2 |
| Philadelphia Electric Co. | Peach Bottom 2 and 3 |
| South Carolina Electric and Gas Co. | Summer 1 |
| Vermont Yankee Nuclear Power Co. | Vermont Yankee 1 |
| Virginia Electric and Power Co. | North Anna 1 and 2 |

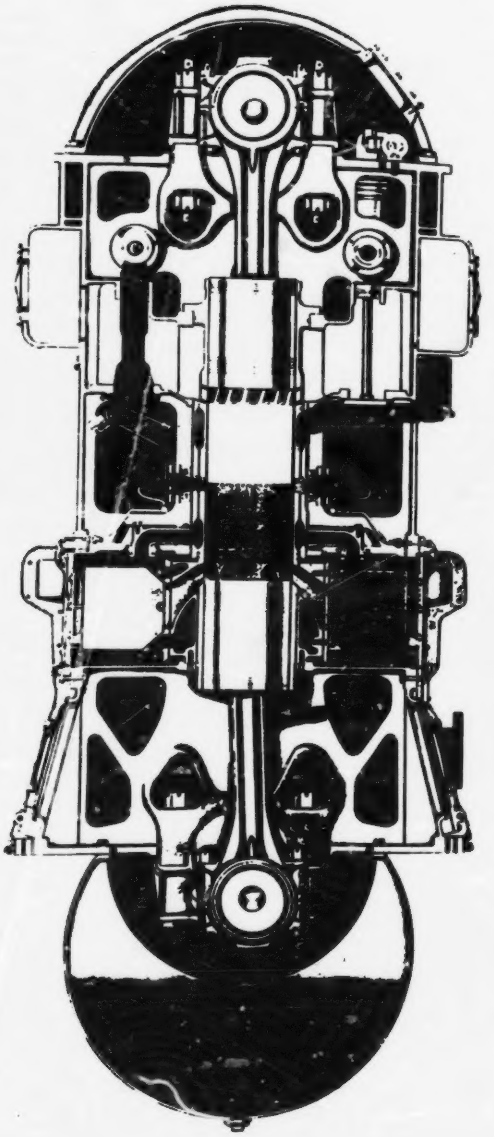

FIGURE 2.9. Cross Section of the Fairbanks Morse OP Engine (Courtesy of Fairbanks Morse Engine Division, Colt Industries Operating Corp.)

A spiral-lobed rotary blower is driven by the engine and supplies combustion and scavenging air. The turbocharger discharges air into the suction side of the rotary blower. A positive displacement gear-type fuel pump is provided, while each cylinder is fed by an individual fuel injection pump, driven from

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the camshafts. A built-in gear pump supplies lube oil to the engine's working components. An oil reservoir serves the upper crankshaft bearings to assure lubrication during startup.

### 2.2.6 Electro-Motive Division of General Motors Corporation

The EMD Series 645 engine (GM 1979a) is built by the Electro-Motive Division (EMD) of the General Motors (GM) Corporation. This engine is a scavenged two-cycle or two-stroke vee-type diesel engine with a cylinder diameter of 9-1/16 in. and a stroke of 10 in. The engine is rated to 190 hp per cylinder and operates at 900 rpm at full load.

Two series of the 645 engines have been built. One series (Type E1) of 8, 12, and 16 cylinders uses a roots-type blower to provide the scavenging as well as the combustion air. The other series of 8, 12, 16, and 20 cylinder (type E4) engines are turbocharged. The turbocharger is basically a single stage turbine with a connecting gear train, driven by the engine gear train.

The EMD stationary power units (GM 1979b) can provide from 800 to 4000 gross hp for generator sets or mechanical drive applications. The stationary power units, when coupled with alternators, can generate 60 Hz at 750 to 900 rpm, respectively, and are rated from 570 to 2865 kW.

Domestic nuclear power plants that have installed EMD series diesels to provide power for the ESF loads in the event of a LOOP or LOCA include those listed in Table 2.6.

A cross-section of an EMD series diesel engine is shown in Figure 2.10.

The crankcase and engine frame is a weldment fabricated from forgings, rolled sections, and plates. The crankshaft is supported by and hung from the frame. The connecting rods are made in an "I-section" shape and consist of a fork and blade combination so that the opposite cylinders do not have to be offset, but can be opposite to each other.

The pistons are two-piece construction. They are mounted on a carrier that holds the piston pin and connecting rod. Thus, the piston and its rings are free to rotate circumferentially in the cylinder. Each cylinder has a unit fuel injector that comprises a cam-driven high-pressure fuel pump and an injector or spray nozzle for spraying fuel into the cylinder.

These engines have air inlet ports near the bottom of the piston stroke, while the exhaust leaves the cylinder through four valves in the cylinder head that are operated by an overhead camshaft. The cylinder head and liner are bolted together to form a powerpack that is bolted to the crankcase.

In the turbocharged series, the centrifugal turbocharger is driven by exhaust gases, with an engine gear drive through an over-running clutch. The over-running clutch is used when starting and while operating at low load.

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TABLE 2.6. Nuclear Plants Using EMD Series Diesel Engines

| Utility | Facility |
|---|---|
| Arkansas Power and Light | Arkansas Nuclear One |
| Commonwealth Edison and Iowa-Illinois Gas and Electric Co. | Quad Cities 1 and 2 |
| Commonwealth Edison Co. | Dresden 1, 2 and 3 |
| Commonwealth Edison Co. | La Salle 1 and 2 |
| Connecticut Yankee Atomic Power Co. | Haddam Neck |
| Duquesne Light Co. | Beaver Valley 1 |
| Florida Power and Light Co. | Saint Lucie 1 and 2 |
| Florida Power and Light Co. | Turkey Point 3 and 4 |
| GPU Nuclear, Inc. | Oyster Creek 1 |
| Maine Yankee Atomic Power Co. | Maine Yankee |
| Niagara Mohawk Power Corp. | Nine Mile Point 1 |
| Northern States Power Co. | Monticello |
| Omaha Public Power District | Fort Calhoun 1 |
| Portland General Electric | Trojan |
| Power Authority of the State of N.Y. | Fitzpatrick |
| Sacramento Municipal Utility District | Rancho Seco 1 |
| Southern California Edison and San Diego Gas and Electric Co. | San Onofre 2 and 3 |
| Tennessee Valley Authority | Browns Ferry |
| Tennessee Valley Authority | Sequoyah 1 and 2 |
| Toledo Edison Co. | Davis-Besse I |
| Virginia Electric and Power Co. | Surry 1 and 2 |
| Wisconsin Electric Power Co. | Point Beach 1 and 2 |
| Wisconsin Public Service Cor. | Kewaunee |
| Yankee Atomic Power Co. | Yankee-Rowe 1 |

Engine starting is accomplished with an air-operated motor. The engines also have engine-driven fuel, lube oil, and cooling water pumps. An additional lube oil pump for piston cooling is provided.

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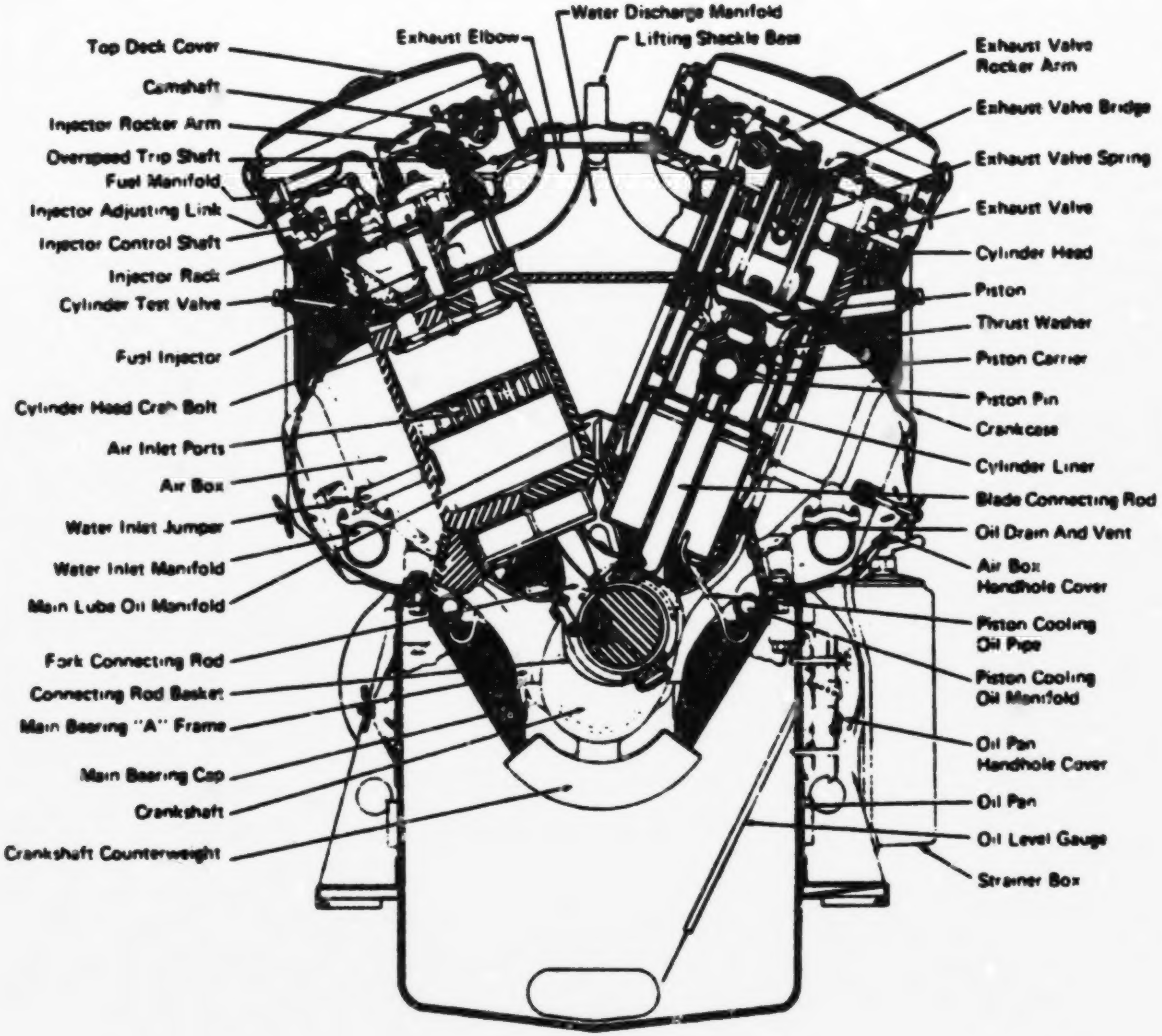
Water Discharge Manifold
Exhaust Elbow
Lifting Shackle Base
Top Deck Cover
Camshaft
Injector Rocker Arm
Overspeed Trip Shaft
Fuel Manifold
Injector Adjusting Link
Injector Control Shaft
Injector Rack
Cylinder Test Valve
Fuel Injector
Cylinder Head Crab Bolt
Air Inlet Ports
Air Box
Water Inlet Jumper
Water Inlet Manifold
Main Lube Oil Manifold
Fork Connecting Rod
Connecting Rod Basket
Main Bearing "A" Frame
Main Bearing Cap
Crankshaft
Crankshaft Counterweight
Exhaust Valve Rocker Arm
Exhaust Valve Bridge
Exhaust Valve Spring
Exhaust Valve
Cylinder Head
Piston
Thrust Washer
Piston Carrier
Piston Pin
Crankcase
Cylinder Liner
Blade Connecting Rod
Oil Drain And Vent
Air Box Handhole Cover
Piston Cooling Oil Pipe
Piston Cooling Oil Manifold
Oil Pan Handhole Cover
Oil Pan
Oil Level Gauge
Strainer Box

FIGURE 2.10. Cross Section of the GM-EMD 645 E Series Engine

### 2.2.7 Nordberg

Nordberg diesel engines were made by the Nordberg Division of Rex Chainbelt, Inc.(a) The Nordberg Series 13 diesel is a four-stroke type engine. It is rated at 350 hp per cylinder and operates at 400 to 514 rpm. It has a bore or cylinder diameter of 13.5 in. and a stroke of 16.5 in.

The Series 13 diesel in-line engines are made with either 6 or 8 cylinders, while the vee engines may have 12, 16 or 20 cylinders. Horsepower ranges from 1620 to 6150 per engine.

Nuclear plants using Nordberg diesel generators are used at the facilities listed in Table 2.7.

A cross section of the Nordberg Series 13 vee-type engine is shown in Figure 2.11. Typical installation arrangements and dimensions are shown in Figure 2.12. The one-piece base or bedplate for Series 13 vee-type engines is cast from Meehanite(b) iron and is stress relieved. The one-piece cast iron engine frame is bolted to the bedplate and supports the underslung crankshaft. The crankshaft is a one-piece, counter-weighted, high tensile steel forging. Connecting rods are closed compression die-forged from high carbon steel. The trunk type, one-piece pistons are cast from ductile iron. Cylinder liners are of the wet design. Cylinder heads are made of ductile iron and contain intake and exhaust valves (one each). Turbochargers are exhaust gas-driven and water cooled. Single or dual turbochargers are employed to meet application requirements. One fuel injection pump and injection nozzle are fitted to each cylinder.

### 2.2.8 Transamerica Delaval Corporation

The Enterprise DSR and DSRV series engines are manufactured by the Engine and Compressor Division of Transamerica Delaval. They are a four-stroke medium-speed engine made in either an in-line or vee configuration. The cylinder diameter is 17 in.; the stroke is 21 in. The engine is rated at about 670 hp per cylinder and operates at 450 rpm. The engine has a BMEP rating of 225 psi.

TABLE 2.7. Nuclear Plants Using Nordberg Diesel Engines

| Utility | Facility |
|---|---|
| Duke Power Co. | McGuire 1 and 2 |
| Carolina Power and Light Co. | Brunswick 1 and 2 |

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(a) Nordberg no longer manufactures diesel engines.
(b) A type of gray cast iron.

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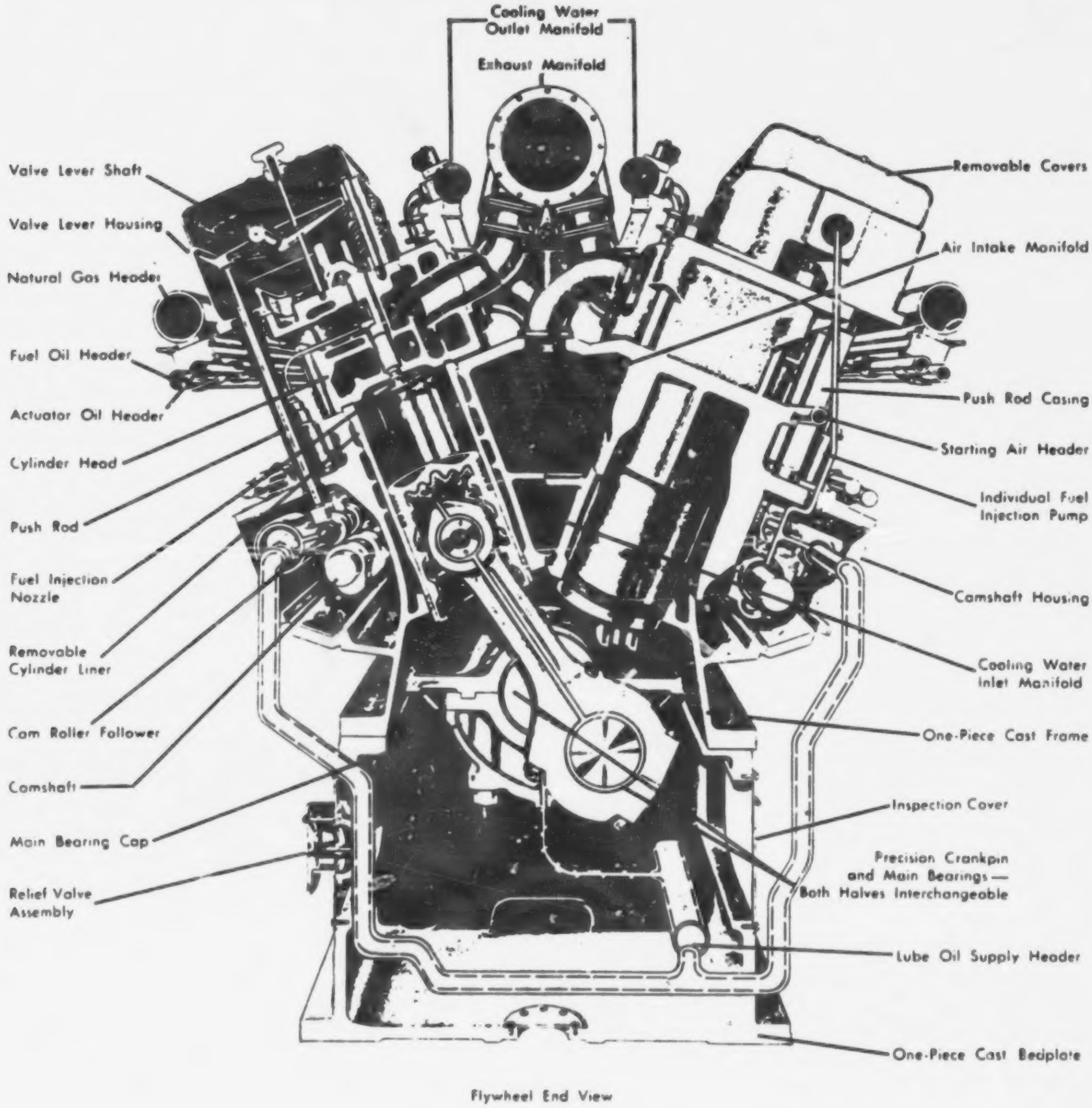
Cooling Water Outlet Manifold
Exhaust Manifold
Valve Lever Shaft
Valve Lever Housing
Natural Gas Header
Fuel Oil Header
Actuator Oil Header
Cylinder Head
Push Rod
Fuel Injection Nozzle
Removable Cylinder Liner
Cam Roller Follower
Camshaft
Main Bearing Cap
Relief Valve Assembly
Removable Covers
Air Intake Manifold
Push Rod Casing
Starting Air Header
Individual Fuel Injection Pump
Camshaft Housing
Cooling Water Inlet Manifold
One-Piece Cast Frame
Inspection Cover
Precision Crankpin and Main Bearings — Both Halves Interchangeable
Lube Oil Supply Header
One-Piece Cast Bedplate
Flywheel End View

FIGURE 2.11. Cross Section of the NORDBERG Series 13 Vee-Type Engine (Courtesy of Energy Services Group, Cooper Industries, Inc.)

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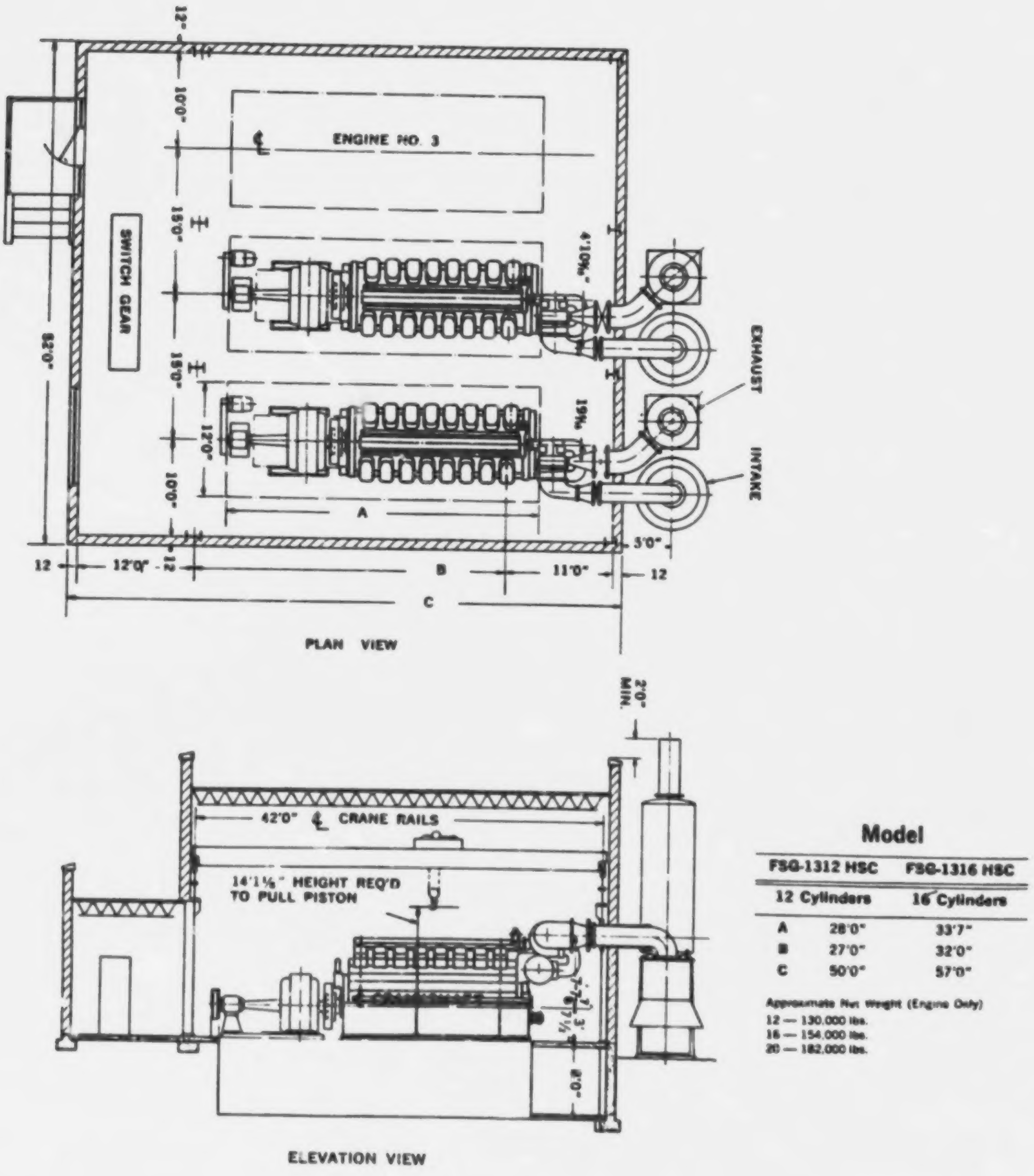
12"
10'0"
℄ ENGINE NO. 3
15'0"
SWITCH GEAR
82'0"
15'0"
12'0"
10'0"
4'10⅝"
19⅝
EXHAUST
INTAKE
A
3'0"
12
12'0"
12
B
11'0"
12
C
PLAN VIEW
2'0" MIN.
42'0" ℄ CRANE RAILS
14'1½" HEIGHT REQ'D TO PULL PISTON
8'0"
ELEVATION VIEW

**Model**

| | FSG-1312 HSC | FSG-1316 HSC |
|---|---|---|
| | 12 Cylinders | 16 Cylinders |
| A | 28'0" | 33'7" |
| B | 27'0" | 32'0" |
| C | 50'0" | 57'0" |

Approximate Net Weight (Engine Only)
12 — 130,000 lbs.
16 — 154,000 lbs.
20 — 182,000 lbs.

FIGURE 2.12. Typical Power Plant Engine Arrangement for Nordberg FSG-1312 HSC and FSG-1316 HSC Engines (Courtesy of Energy Services Group, Cooper Industries, Inc.)

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Six and eight cylinder engines make up the DSR in-line series, while the DSRV engines have been produced in 12, 16, and 20 cylinders. Their rating ranges from 3030 kW to 10,100 kW. A cross section of the TDI RV series diesel engine is shown in Figure 2.13.

Nuclear power plants where TDI diesels have been installed for the ESF loads include those listed in Table 2.8.

The engine base and cylinder blocks are made of cast iron and are bolted together. The crankshaft is made of forged steel and is supported on the base.

Vee-type engines are constructed with articulated connecting rods, which have one rod connected to the crankshaft in the conventional manner with a second unit connected to the first with a roller joint.

The engine has two-piece pistons with a steel crown and iron skirt. Cylinder heads are cast steel and have two intake and two exhaust valves. Liners are iron alloy and are of "wet-type" construction.

Each cylinder has an individual injection pump and nozzle. The pumps are operated from the camshaft and are connected to a common supply header. Turbochargers are provided on all engines--one for the inline series, while two (or four for the V-20 engine) are fitted on the vee engines.

Air is used for starting. The diesel booster pump is a positive displacement type, driven by the engine. The jacket water pump, like the fuel injector pumps, is engine driven. Lube oil pumps are also engine driven.

TABLE 2.8. Nuclear Plants Using TDI Diesel Engines

| Utility | Facility |
|---|---|
| Carolina Power and Light Co. | Shearon Harris |
| Cleveland Electric Illuminating Co. | Perry |
| Duke Power Co. | Catawba |
| Georgia Power Co. | Vogtle |
| Gulf States Utilities Co. | River Bend |
| Long Island Lighting Co. | Shoreham |
| Mississippi Power and Light Co. | Grand Gulf 1 and 2 |
| Sacramento Municipal Utility District | Rancho Seco |
| Southern California Edison and San Diego Gas and Electric Co. | San Onofre 1 |
| Tennessee Valley Authority | Bellefonte |
| Texas Utilities Generating Co. | Commanche Peak |
| Washington Public Power Supply System | WNP 1 |

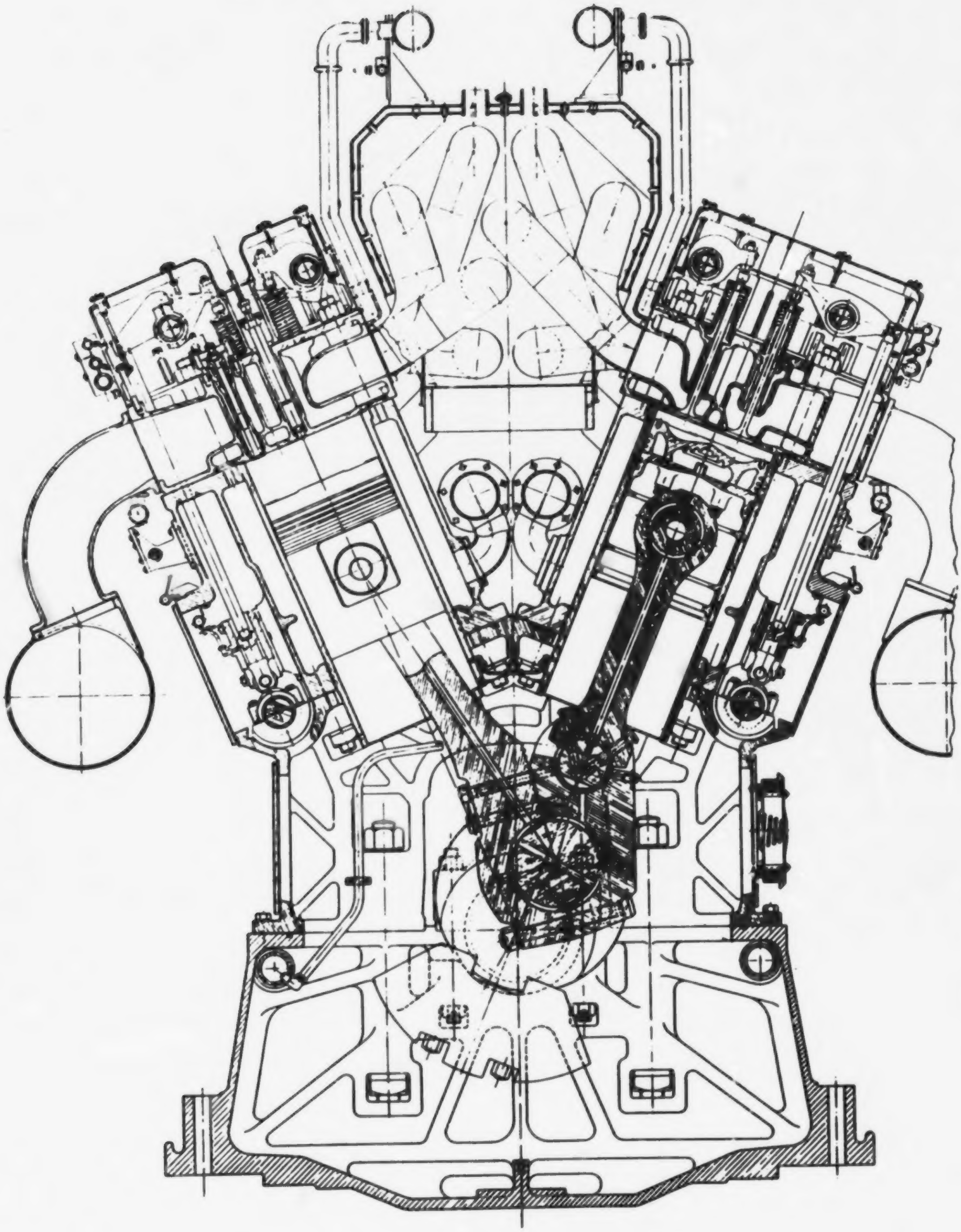

FIGURE 2.13. Cross Sectional View of the TDI-DSRV Series Engine (Courtesy Transamerican Delaval, Inc.)

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### 2.2.9 Worthington

Worthington power engines were manufactured by Worthington Compressor Division of Dresser Industries, Inc.[a] The Worthington type SW turbocharged engines were made as 6 and 8 cylinder in-line and 12, 14, 16, 18 and 20 cylinder vee models. They are rated from 2000 to over 8500 hp (equivalent to 1400 to over 6000 kW) at 514 and 600 rpm.

Worthington diesel generators used in nuclear facilities include diesel-generators at Indiana and Michigan Electric Co.'s Donald C. Cook 1 and 2 facilities at Bridgeman, Michigan.

The machined cast iron base supports the crankshaft, which is forged alloy steel. The engine frame is cast iron and is one piece for both the in-line and vee models. The side-by-side connecting rods for the vee engine and the single rods for the in-line models are interchangeable. The pistons are made of ductile iron. The rigid ductile iron cylinder heads contain two inlet and two exhaust valves. Cylinder liners are made of an iron alloy and have "cast-in," integral water jackets. High-pressure turbochargers are matched to the engines.

## 2.3 STRESSORS

Like all mechanical and electrical equipment, diesel-generator systems and components are subject to aging. Each system and component is affected by its operational history and environment. Engine systems deteriorate, or age, both while operating and standing idle. Since diesel generators in nuclear service are not operated for most of their installed lives, the diesel generator and certain related systems should be considered unique from the aging standpoint when compared to many other systems in a nuclear facility, or diesel-generators in nonnuclear service, which are used extensively.

A number of stressors affect the aging of emergency diesel generators and related systems. These stressors are discussed in this section, and will be researched further in Phase II Engineering Studies.

### 2.3.1 Cooling Water

Corrosion inhibitors, used to control chemical attack or electrolytic action between different metals in a cooling system, become depleted and break down during operations or long periods of inactivity. Uncontrolled water chemistry results in sludge, hard-water inorganic deposits, and rust. Intercoolers, heat exchangers, and other engine components can be affected by corrosion due to poor water chemistry. The efficiency and life of the system can be greatly reduced with incorrect water chemistry.

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(a) Worthington diesel engines are no longer being manufactured.

### 2.3.2 Lubricating Oil

When lubricating oil is used for long periods, the aging process includes effects of increased organic impurities or bacteria content. Water contamination and microbial growth have been found in oil systems. Wear metal and corrosion products also catalyze reactions, adding to the aging process.

Operation of the keep-warm system can cause the oil to oxidize and break down. During startup and nonstabilized engine operation, the buildup of lube oil contaminates is accelerated, and the "clean-up" system's efficiency is reduced. During operation, water contamination or dilution with fuel oil impacts lubricating characteristics.

Oil composition and additives have an impact on its lubricating characteristics and the ability to prevent corrosion, carbon deposits, sludge formation, and varnish buildup. Not using oil recommended by the manufacturer can severely affect the engine.

Carbon or varnish deposits can change the combustion characteristics of an engine. Carbon or sludge in the oil interferes with lubrication.

### 2.3.3 Fuel Oil

The storage of distillate fuel oil can result in physical separation, thickening, and chemical changes due to aging processes. When the oil is stored for long periods, water can accumulate and microbial growth can form. These factors can cause filters to plug rapidly and cause corrosion and seizure of injection system components.

### 2.3.4 Starting Air

When a pneumatic system is static for long periods, water condensate and corrosion may degrade or plug up components such as valves, orifices, and controls. Starting air systems, particularly those operating in humid environments, must ensure adequate air drying capabilities to reduce the effects of moisture introduced into the system.

### 2.3.5 Intake and Exhaust

Intake and exhaust systems are subject to stressors such as dust, moisture, other air contaminants, thermal stresses, vibration, and corrosion. Alkali deposits in the exhaust gas system can cause rapid corrosion by attracting airborne moisture. This is a "down-time" stressor for the exhaust system.

### 2.3.6 Nonmetallic Deterioration

The nonmetallic materials used in seals, gaskets, and hoses are subject to aging by oxidation and oil-induced degradation. Thermal cycling, with brief, hot periods followed by long, cool periods and frequent component removal for inspection, can affect the life of the nonmetallic sealing components. Packing glands wear due to continuous operation in narrow bands of motion while in standby and/or constant load conditions.

### 2.3.7 Dynamic Stresses (Electrical, Mechanical, Electro-Mechanical)

Diesel generators are subject to extreme dynamic loading, especially during fast-start conditions that place unusual demands on components. These components include crankcases, cylinder blocks, pistons, heads, gears, cams, bearings, rollers, crankshafts, connecting rods, electrical components, and controls.

### 2.3.8 Vibratory Stresses

Vibration stresses the crankshaft, flanges, gears, bolts, pipes, supports, and pumps. Misfiring (due to an unbalanced cylinder load) or "working" at the crankshaft flange, which drives the generator, changes engine vibration patterns. The many forced vibration patterns, common to diesel generator systems, produce complex, interacting vibration modes that can affect all components. Oil and water coolers are often subject to pulsating loads that may cause rapid degradation.

### 2.3.9 Thermal Stresses and Thermal Fatigue

Some diesel-generator components such as cylinder liners and exhaust manifolds are subject to thermal stresses. Bolts undergoing great temperature changes can creep (time related failures) and fail or be subject to intergranular failure when exposed to corrosive atmospheres, particularly at high temperatures. Turbocharger vanes, blades, and inlet vane support bolts are subject to this failure mode and low-cycle thermal stress.

### 2.3.10 Dynamic Thermal Stresses

Some diesel engine parts, such as pistons and cylinder heads, are subject to dynamic thermal stresses. Thermal stressing of large mainframe structural components can also be a problem due to the unevenness of the thermoclines within the structures. This is exacerbated by short running times and high loading rates imposed on the engines.

### 2.3.11 Hydraulic Deterioration

Components that are subject to aging due to hydraulic forces (e.g., cavitation) include cylinder heads and liners; water pumps; bearings (especially connecting rod bearings); high pressure lines; fuel lines (fatigue due to pulsation); and the hydraulic loading of air start controls, valves, and lines.

### 2.3.12 Electrical Deterioration

Electrical insulation is subject to aging from oxidation, high temperature exposure, oil contamination, dust and vibrations. Electrical contacts corrode from atmospheric contaminants and normal aging may be accelerated by the presence of moisture. Commutator and slip ring wear accelerates by dust accumulation between uses, or by corrosion due to condensation during periods of inactivity. Probes, lines, contacts, connections, and diodes will all age due to vibration, heat, and chemical attack.

### 2.3.13 Radiation Effects

Diesel generators are not subject to high radiation fields during normal or accident conditions. Accident conditions could conceivably subject units to higher radiation fields that may accelerate equipment aging. Some radiation effects can be initiated at dose rates as low as $10^6$ rad. Exposure to this level is considered almost nonexistent during conceivable accidents. For example, it is noted that there was no radiation exposure to the diesel generators at TMI following the accident at that facility. According to GPU and DOE-TMI staff, there was no decrease in reliability of the TMI diesel generator after the accident. Radiation effects related to aging of the diesel generator probably should not be studied further.

## 3.0 OPERATING EXPERIENCE

The main objective of this investigation was to analyze accurate and representative diesel-generator data that could provide insight into aging processes in diesel-generator systems. Because no single source contains all the information necessary for a reasonable aging evaluation, four major data sources were evaluated to develop a single, representative, analyzed database. Analysis of this database has identified components with potential sensitivity to aging degradation and mechanisms.

This section identifies 1) the approach to and methods of data analysis, 2) the scope and limitations of the data, 3) and the failure modes for and possible causes of the aging degradation of major diesel system components. The complete computer sorts or matrices are provided in Appendixes B and C.

### 3.1 APPROACH

In contrast with other programs reviewing diesel generator performance, the approach used in this research was to identify aging mechanisms and determine their relative contribution to all failures, rather than to statistically record and analyze failure events. This comparative methodology is reflected in the data summary tables of this chapter and is significantly different from other reliability studies.

Although a vast amount of information is available on diesel generators in the nuclear industry, no single source provides the necessary detail to perform a detailed component failure analysis. Additional restrictions to gathering information occur because some vendors, utilities, and contractors view in-depth information gathering with reserve. This is because of concerns regarding the dissemination of proprietary information or being associated with suboptimal performance, the expense of participating in a research effort, and the amount of time involved in the process. Therefore, the information that can be accessed must be integrated and cross-checked to complete a representative characterization of nuclear EDG failure events.

The major effort of this research was to identify the generic systems and components that are most subject to aging degradation. Problems were identified in sufficient depth to recommend immediate mitigating activities and direct future research. No attempt was made to rank or identify poor performance as associated with a utility or a manufacturer in this study.

The approach taken in this report was to qualitatively evaluate a representative sample of available data to derive a useful perspective on what components failed, why they are failing, if the failure is due to an aging mechanism, and what are some preliminary corrective actions that should be taken. The methods used to resolve these issues included the participation of expert diesel consultants who reviewed the available data with knowledgeable objectivity. This process supplied many valuable insights into the meaning of the failure data.

After all the diesel-generator failures were evaluated for aging-related degradation and entered into the database, a computer listing of the failures was reviewed that was sorted by plant, system, and date of failure event. In this way, redundant data from separate data sources could be eliminated by reviewing the adjacent comments sections to identify identical events. In some cases, redundant occurrences were left in the database if team members provided differing insights into the occurrence or if multiple failures occurred. Infrequently, aging related failures were the result of two distinctly different, but coincident, modes of aging degradation.

## 3.2 SCOPE AND LIMITATIONS OF THE DATA

This section identifies the four sources of data that were integrated into one database and discusses the limitations of the analysis.

### 3.2.1 Scope

Four sources of nuclear power plant operating experience were employed to develop the diesel-generator aging-related failure database of this report:

- Licensee Event Reports (LERs)
- Nuclear Plant Reliability Data System (NPRDS)(a)
- Nuclear Power Experience (NPE)
- Emergency Diesel Generator Component Tracking System (EDGCTS).(b)

Although the primary failure data were derived from these four data sources, other sources influenced the direction and focus of the research. These sources include EPRI studies, vendor and contractor recommendations, utility conversations, expert knowledge, industry codes and standards, and NRC regulations and guides. The information from these sources provided industry viewpoints and NRC perspectives (see the bibliography). These viewpoints and perspectives were useful in guiding the data evaluations.

#### 3.2.1.1 Licensee Event Reports (LERs)

This study utilized computer-sorted LER abstracts from the U.S. Department of Energy's (DOE's) DOE/RECON database maintained by AEOD and provided by ORNL. The sample period was from 1965 to 1984. The file contained 2381 diesel-generator failure events: over 500 randomly selected events were used in this study.

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(a) Institute of Nuclear Power Operations data, released for NRC use and analysis only.
(b) As derived from Design Review and Quality Revalidation Report. (TDI OG 1985).

### 3.2.1.2 Nuclear Plant Reliability Data System (NPRDS)

Compiled by the Institute for Nuclear Power Operations (INPO), NPRDS data contain both component and failure information. The purpose of the information is to provide safety-related system-operating statistics for evaluating performance histories, which were used for studies such as probabilistic risk assessments (PRAs). Random entries used in this study number over 500 and represent the period from 1974 through 1984.

### 3.2.1.3 Nuclear Power Experience (NPE)

NPE is an accumulation of operating experience compiled by S. M. Stoller Corporation for U.S. LWRs (Stoller 1982). The data are contained in several volumes, which are cross-referenced and key-worded for direct access and information retrieval. The summaries include the date and the source or cause of the failure, and the repair record detailing corrective action. The data are listed by component and failure. Of all the data sources used, NPE contains the most in-depth background information concerning specific failures. The data address the failures from 1966 through 1984 and represent over 500 random failure entries from the NPE data.

### 3.2.1.4 Emergency Diesel Generator Component Tracking System (EDGCTS)

The EDGCTS database was assembled by the Transamerica Delaval, Inc. (TDI) diesel engine Owners' Group (OG). This group consisted of representatives from nuclear stations with TDI EDGs. This database was used and reported in the OG Design Review and Quality Revalidations Reports (TDI OG 1985) which addressed the suitability of all engine components whose failure could significantly affect engine operations. The EDGCTS database contains operational experiences that are pertinent to diesel-generator reliability. Using input from various nuclear data sources (e.g., INPO, LERs, 10 CFR 50.55, and 10 CFR 21) and non-nuclear sources (marine and stationary engine applications), a substantial database of engine and component operational experiences has been accumulated. The data were collected for the period 1970 through 1984. Only a randomly selected portion of the nuclear industry failures from EDGCTS data was used in this study.

## 3.2.2 Limitations of the Data

Although the primary goal of the analysis of operating experience was to evaluate the causes of failures due to aging degradation, a major aspect of the analysis was to determine the relative frequency of failure types and causes. The failures in this report are representative of the relative failure histories, but may not completely or precisely represent the exact failure rates for various systems and components.

Basic limitations of the analysis arise from:

- the inherent errors intrinsic to a large database

- the lack of detail especially associated with aging and mitigating measures
- the cumulative distribution of operating reactors, varying throughout the years
- changing reporting requirements and practices
- unknown maintenance practices with time
- use of the date of commercial operation as a basis for plant age, when varying years elapsed during startup.

Table 3.1 shows the distribution of failure events used in this study, recorded by year of occurrence and the number of plants operating in each year (AIF 1985). The majority of plant data are failures that have occurred recently, because there were fewer plants in earlier years. This trend is also shown in Table 3.14.

This bias toward younger plants tends to mask failures due to aging degradation, particularly in light of plant operating changes that lead to an increase in recorded data in recent years. Because of this, failures were

TABLE 3.1. Distribution of Failures by Year of Occurrence

| Year of Failure Occurrence | Number of Failure Events | Plants in Operation(a) |
|---|---|---|
| 1965 | 1 | 12 |
| 1966 | 2 | 14 |
| 1967 | 0 | 14 |
| 1968 | 2 | 12 |
| 1969 | 2 | 16 |
| 1970 | 9 | 20 |
| 1971 | 11 | 25 |
| 1972 | 27 | 30 |
| 1973 | 41 | 42 |
| 1974 | 89 | 55 |
| 1975 | 111 | 58 |
| 1976 | 144 | 65 |
| 1977 | 159 | 69 |
| 1978 | 171 | 72 |
| 1979 | 151 | 72 |
| 1980 | 189 | 75 |
| 1981 | 238 | 78 |
| 1982 | 240 | 83 |
| 1983 | 254 | 86 |
| 1984 | 143 | 93 |

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(a) From AIF 1985.

normalized to failures per 100 failures in each computer sort category. While this assuages the age distribution problem, it also interjects an increasingly larger chance of error for failures associated with older plants, due to the lack of data.

Because the data center on younger plants, with failures occurring early in life, many clues about long-term aging are hidden. For example, the comparison of aging effects centers around the 5-year point (the age of the plant at the time of failure) due to a lack of data from plant failures later in life. Future research should focus on failure mechanisms associated with older plants, which may provide stronger indications of aging trends.

Other significant limitations of the data and analysis are due to the unknown effects of maintenance, continuously interacting with diesel-generator systems. Basic assumptions about the age of the plant at the time of failure and aging trends tend to be leveled by the unknown number and periodicity of replaced components. Additionally, maintenance activities statistically look like original installation activities from a failure evaluation perspective (Prichard 1984). That is, overhauling equipment in mid-life introduces problems such as incorrectly torqued fasteners and poorly assembled parts that mirror failures found in original construction. Differentiating between these failure causes is almost impossible in view of the many functional and design differences within the sample distribution, and the lack of detailed site-specific machinery histories.

It must be emphasized that, because of the limitations identified, relative failure rates in this study should be used only as an indicator of aging phenomena. Therefore, this data analysis should be used to identify problems for future aging research that may--sometime in a system's life--jeopardize diesel-generator operational readiness.

## 3.3 METHODS OF DATA ANALYSIS

Over 500 failure incidents that occurred from 1965 to 1984 were randomly sampled from each of the four data sources (see Section 1.3.1) to form a representative database which, after editing, resulted in 1,984 evaluations of diesel-generator and related systems failure. Diesel experts and PNL staff members reviewed each incident to evaluate the role of aging in the recorded failure.

In evaluating any failure event, aging was considered a contributing factor when a noticeable decrease in reliability could be associated with the identified aging process. Because of the broad nature for the definition of aging, a select range of failure causes were used to generally categorize the failure data into isolatable topics.

Each failure associated with the selection of systems and components presented in Table 3.2 was evaluated for primary and secondary causes of failure, primary and secondary recommended corrective actions for the listed failure, and whether aging or abnormal aging (see 1.5, Definition) may have contributed

## TABLE 3.2. Systems and Components Analyzed

Engine Structure
- a) Base
- b) Crankcase
- c) Cylinder Block
- d) Heads
- e) Main Bearings
- f) Liners
- g) Other

Drive Train
- a) Crank Shaft
- b) Connecting Rods
- c) Pistons
- d) Gears
- e) Camshaft
- f) Flywheel
- g) Connecting Rod Bearings
- h) Other

Valve Mechanisms
- a) Pushrods
- b) Rocker Arm Assembly
- c) Intake and Exhaust Valves
- d) Other

Starting Components
- a) Starting Air Distributors
- b) Starting Air Valves
- c) Air Compressors
- d) Controls
- e) Barring Device
- f) Strainers and Filters
- g) Tanks
- h) Starting Motors
- i) Other

Intake and Exhaust
- a) Air Filter
- b) Turbo Charger
- c) Silencer (Muffler)
- d) Other

Instruments and Controls
- a) Governor
- b) Overspeed Governor
- c) Control Valves
- d) Alarms and Shutdowns
- e) Linkages
- f) Startup System
- g) Control Air System
- h) Wiring/Terminations
- i) Relays
- j) Sensors
- k) Other

Electrical Systems
- a) Switches
- b) Wiring, Conduit, etc.
- c) Transformers
- d) Controls
- e) Other

Unrelated to EDG
- a) Manual Shutdown
- b) Other

Fuel Components
- a) Injector Pumps
- b) Filters Strainers
- c) Fuel Oil Pumps
- d) Oil Storage
- e) Piping on Engine
- f) Injectors and Nozzles
- g) Fuel
- h) Other

Lubrication Components
- a) Pumps
- b) Filters
- c) Strainers
- d) Heat Exchangers
- e) Control Valves
- f) Piping
- g) Lube Oil
- h) Other

Cooling Components
- a) Pumps
- b) Heat Exchangers
- c) Intercooler
- d) Radiator
- e) Cooling Tower
- f) Piping
- g) Cooling Water
- h) Other

Generator Components
- a) Generator
- b) Exciter
- c) Voltage Regulator
- d) Pedestal Bearings
- e) Other

Switchgear Components
- a) Breakers
- b) Relays
- c) Instruments and Controls
- d) Other

Structural Components
- a) Engine Foundation
- b) Rails, Chocks, Grout, etc.
- c) HVAC
- d) Drainage of Waste
- e) Other

Mechanical Systems
- a) Valves
- b) Piping and Fittings
- c) Piping Supports
- d) Other

EDG Functions
- a) Procedures, Preventive
- b) Procedures, Corrective
- c) Procedures, Surveillance
- d) Other

Miscellaneous
- a) Platforms, Ladders, etc.
- b) Other

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to the failure. Table 3.3 shows the codes for the failure causes used in the component/failure-cause matrix, and Table 3.4 shows the codes used for identifying recommended corrective actions for each failure evaluated.

TABLE 3.3. Failure Causes

| Code | |
|---|---|
| a | Poor design: wrong application or component |
| b | Poor manufacturing or construction/quality control |
| c | Overstress:by unanticipated but normal conditions |
| d | Adverse conditions: vibration, shock, etc. |
| e | Adverse environment: dust, humidity, chemicals, etc. |
| f | Erroneous installation application |
| g | Maladjustment/misalignment |
| h | Electrolysis, stray currents |
| i | Human error - operation |
| j | Human error - maintenance |
| k | Fire/flood/other casualty/calamity |
| l | External disturbances - transmission grid |
| m | Unknown/other |
| n | Poor system design |

TABLE 3.4. Recommended Corrective Actions

| Code | |
|---|---|
| a | Maintenance - realignment, adjustment |
| b | Repair - welding, grinding |
| c | Replacement: same type of component |
| d | Replacement: new or upgraded type of component |
| e | Redesign |
| f | Enhanced surveillance |
| g | Changes to operating conditions, parameters, environment |
| h | Enhanced training, management, records |
| i | Enhanced preventive maintenance |
| j | Unknown/none |

The database was coded for computer entry. The results of the computer analyses are presented in Appendixes B and C in component/analysis matrices. Categories of systems included in the analysis are presented in Table 3.2 with their corresponding components.

Each failure event was accompanied by a detailed description of the failure (up to 250 words can be entered in the Comments section of the data entry sheet). This section of the database is "word searchable" so that key words such as "vibration" may be selected from Category d, "adverse conditions," in Table 3.3. Additionally, various computer sorts, such as those by system and component, could assemble all comments for a particular field for evaluation. Similarly, the Comments section was used to clarify recommended corrective actions for each failure.

The format selected for the computer output was a component/analysis matrix. Due to the diversity of information in the database, an interesting and valuable selection of computer produced matrices was possible. The resulting matrices provided indications of aging processes and a basis for the aging analysis. The component/analysis matrices used were categorized into 4 groups, totaling 50 matrices (see Table 3.5).

Group I component/failure-cause matrices provide an overview of all the industry failures from 1965 to 1984. A comparison of aging and nonaging related failures was made to characterize aging problems from an overall perspective.

Group II component/failure-cause matrices identify the changing failure modes over the years a diesel generator is in service. Changes in failure modes, specifically related to aging degradation, can be isolated by reviewing failures from select periods of service life. For example, all failures <1 year include the period from installation to commercial operation, a period of extensive diesel-generator testing and use that may span many years.

Group III component/failure-cause matrices were formulated not to compare engines or manufacturers, but to identify problematic areas for each engine type. Our intent was to isolate problems of aging that may be unique to a particular system. Obviously, numerous variations in engines and engine systems exist within the industry. As a result, some prioritization of systems must be exercised to focus future attention on identified problem areas. Problems that may be endemic to one particular material, design, or interface should not be classified as problems endemic to all engines.

Group IV component/recommended-corrective-action matrices characterize the overall recommendations for corrective actions associated with all failures and all failures due to aging degradation. These matrices form a general indicator of what should be done to correct or mitigate aging problems.

All four groups represent the ways the identified systems and components age. The failures reflect only the tendency to exhibit a mode of aging degradation when aging occurs. Simply stated, the failures do not reflect overall reliability, but if a failure occurs, it will show the component most likely to fail by aging degradation. Therefore, the computer analysis is used as an indicator of potential aging problems and tends to characterize the role of aging in component failures.

## 3.4 FAILURE MODES AND CAUSES

This section evaluates failures for evidence of aging degradation by:

- an evaluation of component/failure-cause matrices

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## TABLE 3.5. Component/Analysis Matrices

Group I, Overview matrices:
- All failures
- All aging related failures
- All abnormal failures
- All aging related abnormal failures.

Group II, Aging indicator matrices:
- All failures, <1 year
- All failures, >1 year
- All failures, >5 years
- All aging failures = 0 years
- All aging failures, >5 years
- All aging failures, <=5 years
- All aging failures 1 through 20 years.

Group III, Engine system matrices:

ALCO - all failures
all aging related failures

Allis Chalmers - all failures
all aging related failures

Caterpillar - all failures
all aging related failures

Cooper Bessemer - all failures
all aging related failures

Electro-Motive Division - all failures
all aging related failures

Fairbanks Morse - all failures
all aging related failures

Nordberg - all failures
all aging related failures

Transamerica Delaval - all failures
all aging related failures

Worthington - all failures
all aging related failures.

Group IV, Recommended corrective action matrices:
- All failures and corrective action
- All aging related failures and corrective action.

- a review of the database comments associated with failures for each system and component

- review of the secondary failure causes for each failure.

The tables in this section were derived from the component/failure-cause matrices using only primary failure causes. The text and discussions in this section reflect an integration of the above three methods of using the database. For example, word-searching the comments for "vibration" listed all comments where "vibration" appeared anywhere in the comments text. Any combination of failure causes, systems and components, manufacturer, etc., could be listed with each comment. Additionally, selected computer listings of primary and secondary failure causes and recommended corrective actions were used to clarify specific failure categories and modes.

### 3.4.1 Group I Matrices: General Indicators

#### 3.4.1.1 All Failures

Table B.1, Appendix B, shows the distribution of all failures for EDG systems. The analysis included 1,984 failures of diesel systems in nuclear service from 1965 to 1984, with the majority of the recorded failures occurring between 1974 and 1984. The significant overall causes of failure are shown in Table 3.6.

The systems and components that contributed most to the failures are shown in Table 3.7. The failures, categorized under "other systems," are evenly distributed among the systems. Only components that significantly contribute to the overall system failure rate are included in this and the remaining tables in this chapter. For a complete representation of the data analysis, see the component/analysis matrices in the appendices.

Drive train components and engine valve mechanisms faired well overall. The drive train system showed 3 failures per 100 failures, with the majority of the failures associated with the pistons, while engine valve mechanisms failed

TABLE 3.6. Overall Causes of Diesel-Generator Failure

| Failure Cause | Percent of All Failures(a) |
|---|---|
| Poor manufacturing or construction quality control | 22 |
| Adverse conditions: vibration, shock | 17 |
| Human error - maintenance | 13 |
| Adverse environment: dust, humidity, chemicals, etc. | 13 |
| Unknown | 11 |
| Maladjustment/misalignment | 8 |
| Other | 16 |

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(a) Includes aging and nonaging failures.

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TABLE 3.7. Systems and Components Contributing Most to All Diesel-Generator Failures

| Systems and Components | Percent of All Failures | |
|---|---|---|
| Instruments and Controls System | 25 | |
| Governor | | 10 |
| Sensors | | 3 |
| Relays | | 2 |
| Startup components | | 2 |
| Fuel System | 11 | |
| Piping on engine | | 3 |
| Injector pumps | | 2 |
| Starting System | 10 | |
| Controls | | 3 |
| Starting air valve | | 2 |
| Starting motors | | 2 |
| Air compressor | | 1 |
| Switchgear System | 10 | |
| Breakers | | 3 |
| Relays | | 5 |
| Instruments and controls | | 1 |
| Cooling System | 9 | |
| Pumps | | 2 |
| Heat exchangers | | 2 |
| Piping | | 2 |
| Lubrication System | 7 | |
| Heat exchangers | | 2 |
| Pumps | | 2 |
| Lube oil | | 1 |
| Other Systems | 28 | |

at a rate of 1 per 100. A general perspective of the overall failure distribution indicates that support systems and interfaces seem to be more subject to failure than the basic engine components.

#### 3.4.1.2 All Failures Due to Aging

Table B.2, Appendix B, shows that of 1,984 failures, 1,064 were related to some form of aging degradation. The overall major failure causes due to aging are shown in Table 3.8. The systems and components that contributed most to aging failures are shown in Table 3.9.

TABLE 3.8. Causes of Diesel-Generator Failure Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 27 |
| Poor manufacturing or construction quality control | 18 |
| Adverse environment: dust, humidity, chemicals, etc. | 17 |
| Unknown | 14 |
| Human error - maintenance | 9 |
| Maladjustment/misalignment | 6 |
| Poor design: wrong application or component | 5 |
| Other | 4 |

Failure causes were generally classified as "Unknown/Other" for two reasons; first if, within the evaluator's judgment, the data were insufficient to allow a reasonable interpretation of the failure mechanism and second, if the cause could not be assigned to one of the other predetermined classifications. A review of the comments for those failures classified as "Unknown" reveals a failure distribution that may be consistent with the overall failure distribution. This indicates that the unknown category may reflect a lack of adequate data rather than a lack of technical knowledge about unknown failure mechanisms.

Examination of the comments associated with the various failure causes reveals that vibration loosening of fasteners and metal fatigue are a major cause of aging for diesel-generator systems. A review of the component/failure-cause matrix indicates that components in the instruments and controls system (including the governor, alarm system, control air system, and terminations), the cooling system pumps and piping, the fuel system injector pumps and engine piping, and the turbocharger are particularly sensitive to vibration-induced failure.

### 3.4.1.3 All Abnormal Failures

Abnormal failures, discussed in this section, are failures that will result in loss of function and impairment of reliability (see Definitions, Section 1.5). Table B.3, Appendix B, shows that of 1,984 failures reviewed, 1,336 were classified as abnormal failures; 629 are aging related. Although abnormal failures included the subset of all aging-related abnormal failures, it is interesting to compare the failure modes of each category. The causes of overall abnormal failure are shown in Table 3.10. The systems and components identified as being the major contributor to this group are shown in Table 3.11.

### 3.4.1.4 All Abnormal Aging Failures

Table B.4, Appendix B, shows that of 1,984 failures evaluated, 629 were classified as abnormal failures due to aging degradation. Table 3.12 is a breakdown of the major failure causes in this category.

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TABLE 3.9. Systems and Components Contributing Most to Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | |
|---|---|---|
| Instruments and Controls | 28 | |
| Governor | | 12 |
| Fuel Components | 13 | |
| Engine piping | | 5 |
| Injector pumps | | 3 |
| Starting System | 10 | |
| Starting air valve | | 3 |
| Controls | | 3 |
| Starting motors | | 2 |
| Cooling System | 10 | |
| Pumps | | 2 |
| Piping | | 2 |
| Heat exchangers | | 2 |
| Lubrication System | 8 | |
| Pumps | | 2 |
| Heat exchangers | | 2 |
| Lube oil | | 1 |
| Other Systems | 31 | |

TABLE 3.10. Causes of All Abnormal Diesel-Generator Failures

| Failure Cause | Percent of Abnormal Failures |
|---|---|
| Poor manufacturing and construction quality control | 29 |
| Adverse conditions: vibration, shock | 18 |
| Human error - maintenance | 13 |
| Adverse environment: dust, humidity, chemicals, etc. | 12 |
| Poor design: wrong application or component | 9 |
| Other | 19 |

TABLE 3.11. Systems and Components Contributing Most to All Abnormal Diesel-Generator Failures

| Systems and Components | Percent of All Failures | |
|---|---|---|
| Instruments and Controls System | 23 | |
| Governor | | 10 |
| Sensors | | 4 |
| Relays | | 2 |
| Fuel System | 11 | |
| Engine piping | | 3 |
| Injector pumps | | 3 |
| Switchgear System | 10 | |
| Relays | | 5 |
| Breakers | | 3 |
| Starting System | 9 | |
| Starting air valve | | 3 |
| Starting motors | | 2 |
| Controls | | 2 |
| Other Systems | 47 | |

TABLE 3.12. Causes of Abnormal Failures Due to Aging

| Failure Cause | Percent of Aging-Related Abnormal Failures |
|---|---|
| Adverse conditions: vibration, shock | 32 |
| Poor manufacturing or construction quality control | 23 |
| Adverse environment: dust, humidity, chemicals, etc. | 15 |
| Human error - maintenance | 9 |
| Poor design: wrong application or component | 7 |
| Other | 14 |

A review of the failures indicates a change from manufacturing and construction quality control problems, as the main cause of all abnormal failures, toward vibration as the main cause for abnormal aging failures. Similarly, a shift occurred with maintenance errors and adverse environment; that is, an adverse environment seems to cause abnormal aging degradation more than maintenance errors.

Table 3.13 provides a breakdown of the systems and components most subject to abnormal aging failures.

TABLE 3.13. Systems and Components Contributing to Abnormal Failures Due to Aging

| Systems and Components | Percent of Abnormal Aging-Related Failures | |
|---|---|---|
| Instruments and Controls System | 26 | |
| Governor | | 12 |
| Control air system | | 3 |
| Wiring and terminations | | 2 |
| Sensors | | 2 |
| Fuel System | 15 | |
| Engine piping | | 7 |
| Injector pumps | | 5 |
| Injectors and nozzles | | 2 |
| Starting System | 10 | |
| Starting air valve | | 5 |
| Controls | | 2 |
| Starting motors | | 2 |
| Cooling System | 10 | |
| Piping | | 3 |
| Pumps | | 2 |
| Heat exchangers | | 2 |
| Engine Structure | 9 | |
| Crankcase | | 3 |
| Liners | | 2 |
| Main bearings | | 2 |
| Other Systems | 30 | |

### 3.4.1.5 Findings for Group I Matrices: General Indicators

Several differences are revealed between the systems and components most subject to aging degradation and the systems and components listed for all failures. The Instruments and Control System was most subject to failures in all failure categories, but the components within the instruments and control system changed failure modes with aging failures. The governor was the component most subject to failure in all areas, with the control air system, wiring and terminations, and sensors also found to be susceptible to abnormal aging failures. Of these, sensors were listed on all failures and all abnormal aging failures. Clearly, these components and associated interfaces are subject to aging degradation. A review of the component failure-cause matrix (Table B.4, Appendix B), shows that vibration is the primary cause of failure and that vibration loosening is the primary mechanism of degradation. The high percentage of failures due to poor construction/manufacturing indicates that construction defects or errors may cause the governor to be subject to vibration degradation.

After the Instrumentation and Controls System, the Fuel System was next in susceptibility to aging degradation. Engine piping, injector pumps, and injectors consistently appeared in most failure categories. In these failures, vibration loosening was again a major degradation mechanism. The primary failure cause for piping was vibration, while the failure causes for injectors and injector pumps were evenly distributed between poor manufacturing/construction, vibration, and environmental influences.

Within the Starting System, the starting air valves, controls, and starting motors were identified as susceptible to aging degradation. An adverse environment was identified as the principal cause of aging. A review of related comments and secondary failures revealed poor system design as a major contributor. This indicates that the system--subject to degradation by corrosion, fouling, and moisture intrusion--is designed without sufficient consideration for potential failure patterns.

The Cooling System experienced aging degradation of piping, pumps, and heat exchangers. While pump and piping failures were primarily attributed to vibration loosening of connections (fasteners), the causes of heat exchanger failure were evenly distributed between vibration and manufacturing/construction quality. Vibration damage in heat exchangers was generally caused by loose internals from original construction.

The Engine Structure was the last identifiable system in the matrix of abnormal aging failures. Although an examination of all failures shows this system to have few failures, the computer sort restricted to abnormal aging identifies the crankcase, cylinder liners, and main bearings as prone to aging degradation. This indicates that engine structure failures were a larger fraction of failures due to abnormal aging. Crankcase failures were attributed to vibration damage and improper operation. Liner failures were associated with poor manufacturing/construction, poor design, and vibration, while the main bearing failures were caused by poor maintenance and design. Poor design accompanied with maintenance problems, as a cause of failure, may indicate that the identified components and system(s) are not adequately designed for maintainability.

### 3.4.2 Group II Matrices: Time Related Indicators

The segregation of aging failures into time periods provides a useful basis from which to evaluate aging degradation. Comparing the failure rates and mechanisms of older equipment to younger equipment indicates changing failure patterns and thus suggests the onset of aging degradation or time-dependent degradation.

During the analysis it became apparent that the aging rates for various components were not the same. For example, short-term aging degradation due to vibration for the fuel oil piping on an engine was different from the intermediate-term degradation caused by dust or dirt in electrical components or the long-term corrosion of structural members.

Because the data from many plants were accumulated in each age category, an overall perspective did not reveal sharp indications of aging trends. By isolating equipment failures by the age of the plant at time of failure, more definite trends--although subtle--began to appear. Since regulatory changes--affecting the construction, operation, maintenance, and testing of diesel-generator systems--have introduced complex factors into performance histories, subtle indications of aging may actually be significant trends. Only more detailed, site-specific research can confirm this assumption.

### 3.4.2.1 Aging Trends

Figure 3.1 shows the percent of failures due to aging degradation for any plant at a particular age. The resultant graph shows the changing ratio of aging related failures to all failures, or:

$$\text{\% of failures due to aging} = \frac{\text{failures due to aging}}{\text{all failures}}$$

A plot of this ratio for each year from the commercial operation date (0 years) through 14 years of operation reveals that aging degradation is an increasingly larger percentage of total failures for nuclear service diesel generators. Table 3.14 lists the total number of failures and the total number of aging related failures for each year. Note that at 0 years an engine may already have several years of testing and wear exposure.

Various factors influence trends in Figure 3.1. Certainly changing requirements have influenced the construction of engine systems and the attention they receive during manufacturing and nuclear service. Several conversations with major contractors, who have prepared diesel-generator packages for nuclear service, suggest that changing regulatory requirements over the last few years have increased the cost and complexity of the diesel-generator system. For example, they indicated that parts, which were previously "time tested" to be reliable in non-nuclear service, may, under the applicable nuclear regulations and codes, not be qualified for current nuclear service application. In some instances, new parts, to replace the "unqualified" old parts, have been manufactured to the newer standards. Due to the lack of field testing of the newer parts and systems, some new parts have proved to be more failure-prone than the corresponding old parts, even while technically complying with the newer standards (see also Chapter 5.0).

Because most of the data are from newer plants, a resultant leveling of the aging plot may have occurred that reduces the increased aging degradation trends. Additionally, increased attention to diesel-generator systems has resulted in more problems being identified and reported in later years, introducing an additional bias that masks the aging process by flooding the data with nonaging failures in later years.

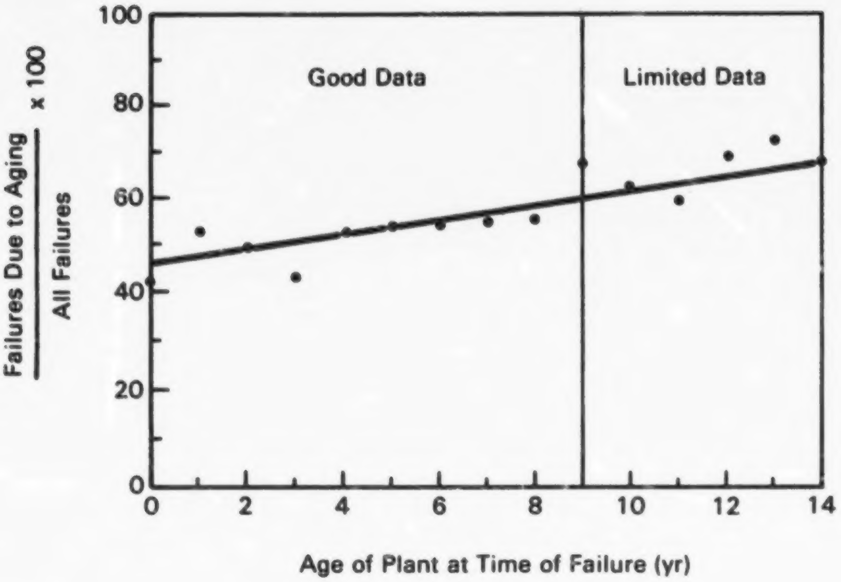

FIGURE 3.1. Percent of Failures Due to Aging

The tables in this section, showing system and component failure percentages, only list components that are significant contributors to the overall failure percentage for the associated system. Appendix B contains the complete failure profiles.

#### 3.4.2.2 All Failures Less Than 1 Year

A review of all aging and nonaging failures that occurred before the first year of plant operation highlights all failures associated with diesel-generator systems throughout power plant construction and startup phases (compared to operational phase). The startup period is generally a long period (sometimes 10 years) of extensive maintenance and testing that can place rigorous demands on new equipment.

Inspection of the component/failure cause matrix for the <1 year category reveals a predominant manufacturing and construction quality problem. Table 3.15 summarizes the major indicators from Table B.5, Appendix B. A review of the data from this time period is necessary to accurately represent the characteristics of all failure causes early in life.

The total number of failures for <1 year is 354, representing the problems encountered during startup. The systems and components most subject to failure in this category are listed in Table 3.16. A review of the last column indicates that design, manufacturing, and construction problems are associated with the startup phases for a nuclear service diesel-generator system.

TABLE 3.14. Diesel Failure Database: Failure Count by Year

| Age of Plant[(a)] | All Failures | Failures Due to Aging and Wear | Data Type |
|---|---|---|---|
| 0 | 354 | 155 | "good" |
| 1 | 201 | 109 | |
| 2 | 142 | 71 | |
| 3 | 142 | 63 | |
| 4 | 136 | 72 | |
| 5 | 193 | 107 | |
| 6 | 185 | 102 | |
| 7 | 171 | 96 | |
| 8 | 101 | 57 | |
| 9 | 107 | 73 | |
| 10 | 88 | 55 | "limited" |
| 11 | 58 | 35 | |
| 12 | 36 | 25 | |
| 13 | 22 | 16 | |
| 14 | 23 | 16 | |
| 15 | 7 | 2 | "insufficient" |
| 16 | 8 | 5 | |
| 17 | 3 | 2 | |
| 18 | 3 | 1 | |
| 19 | 5 | 1 | |
| 20 | 4 | 4 | |

---

(a) Based on date of commercial operation.

TABLE 3.15. Causes of Failures that Occur in Plants <1 Year Old

| Cause of Failure | Percent of All Failures |
|---|---|
| Poor manufacturing and construction quality control | 30 |
| Poor design: wrong application or component | 12 |
| Adverse conditions: vibration, shock | 10 |
| Adverse environment: dust, etc. | 10 |
| Human error - maintenance | 10 |
| Other | 28 |

TABLE 3.16. Systems and Components Contributing Most to Failures During Startup

| Systems and Components | Percent of All Failures | | Main Failure Cause Codes[(a)] |
|---|---|---|---|
| Instruments and Controls System | 23 | | |
| Governor | | 9 | b, a |
| Sensors | | 4 | b, j, m |
| Relays | | 3 | d, g |
| Switchgear Components | 12 | | |
| Relays | | 8 | b, a |
| Breakers | | 3 | b |
| Fuel System | 10 | | |
| Piping on engine | | 3 | b, d |
| Starting System | 10 | | |
| Starting air valve | | 4 | e |
| Other Systems | 45 | | |

---

(a) See code definitions in Table 3.3.

### 3.4.2.3 Aging Failures <5 Years and >5 Years

Table 3.17 compares the causes of failure for <5 year and >5 year categories. The comparison indicates that the failure causes change as equipment age increases.

For aging only, the 5-year mark represents an approximate midpoint in the amount of data used. It was found that 489 aging-related failures occurred with equipment greater than 5 years old (based on the plant age from the time of commercial operation), and 575 aging related failures occurred with equipment less than or equal to 5 years. The 5-year point was selected to ensure that an adequate cross section of failures was sampled for an optimal indication of aging trends.

### 3.4.2.4 Examination of Findings for Group II Matrices

A study of the changes in failure patterns exhibited in Tables 3.17 and 3.18 reveals subtle shifts in failure mechanisms. The similar aging failure percentages of Table 3.17 indicate an averaging of failure percentages for different systems and components. Regardless, several trends emerge from the data. The percentage of aging failures due to vibration, adverse environment, and overstressing increases or stays constant for plants over 5 years.

A review of Table 3.18 indicates that while some components seem to emerge from their "burn-in" period having resolved many failure problems, other

TABLE 3.17. Causes of Diesel-Generator Failure Less Than and Greater Than 5 Years

| Cause of Failure | Percent of Aging-Related Failures <5 yr | >5 yr |
|---|---|---|
| Poor design: wrong application or component | 5 | 4 |
| Poor manufacturing or construction quality control | 19 | 17 |
| Overstress: by unanticipated conditions | 1 | 2 |
| Adverse conditions: vibration, shock, thermal | 26 | 29 |
| Adverse environment: dust, chemicals, etc. | 16 | 18 |
| Erroneous installation application | 1 | -- |
| Maladjustment/misalignment, etc. | 6 | 5 |
| Electrolysis, stray currents | -- | -- |
| Human error - operation | 2 | 1 |
| Human error - maintenance | 9 | 9 |
| Fire/flood | 1 | -- |
| External disturbances - transmission grid | -- | -- |
| Unknown | 14 | 13 |
| Poor system design | -- | -- |
| Other | -- | 2 |

components are experiencing increased aging failure percentages and changing failure patterns. For example, problems associated with the following components seem to decrease after the 5-year point:

- instruments and control system
  - relays
- fuel system
  - piping on engine
- starting system
  - starting air valve
- lubrication system
  - heat exchangers
  - lube oil
- engine structure
  - crankcase
- drivetrain
  - pistons
- switchgear system
  - breaker.

## TABLE 3.18. Systems and Components Contributing to Failures Less Than and Greater Than 5 Years

| | Percent of Aging-Related Failures | | Main Failure Cause Codes[(a)] | |
|---|---|---|---|---|
| Systems and Components | <5 yr | >5 yr | <5 yr | >5 yr |
| Instruments and controls | 27 | 29 | | |
| Governor | 11 | 13 | b, d, e, j | b, d, e, j |
| Relays | 3 | 2 | d, e | d |
| Sensors | 3 | 3 | d | d, b |
| Control air | 2 | 2 | d | d, j, e |
| Fuel System | 14 | 13 | | |
| Piping on engine | 6 | 3 | d, b | d |
| Injector pumps | 3 | 4 | b, d | d, e |
| Injectors and nozzles | 2 | 2 | d, b, e | e, d |
| Cooling System | 8 | 11 | | |
| Pumps | 2 | 3 | e, g | d, j |
| Heat exchangers | 1 | 2 | d, e | b |
| Piping | 2 | 3 | d, b, j | d |
| Starting System | 11 | 10 | | |
| Controls | 2 | 3 | e, a | e, j |
| Starting motors | 2 | 3 | e | e, m |
| Starting air valve | 4 | 2 | e | e |
| Lubrication System | 8 | 7 | | |
| Pumps | 1 | 3 | e | d, e |
| Heat exchangers | 2 | 1 | b, d | e |
| Lube oil | 2 | - | e | b, e |
| Filters | 1 | 1 | b, d, e | j |
| Intake and exhaust | 6 | 6 | | |
| Turbocharger | 4 | 5 | b | b, d, m |
| Engine structure | 7 | 6 | | |
| Crankcase | 3 | 2 | i | d, e |
| Drivetrain | 5 | 2 | | |
| Pistons | 2 | 1 | b | a, b, e |
| Connecting rods | 1 | - | a, d | |
| Crankshaft | 1 | - | b | |
| Generator System | 5 | 4 | | |
| Generator | 1 | 2 | m | b, d |
| Voltage regulator | 2 | 2 | b, g, m | b, e, m |
| Switchgear components | 4 | 4 | | |
| Relays | 1 | 2 | a | b |
| Breakers | 2 | 1 | j | b, g |
| Electrical Systems | 2 | 4 | | |
| Controls | 1 | 1 | m | b, d |
| Other Systems | 3 | 4 | | |

---

(a) See Table 3.3 for code definitions.

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Even though the overall aging failure percentage on some of the above equipment decreased past the 5-year mark, the causes of aging failure may have changed. For example, the relays in the instrumentation system and the heat exchangers in the lubrication system experienced an overall decrease in their aging failure percentage, yet their aging failures due to vibration increased. This could indicate that the component is experiencing a failure mode change from "burn-in" to "maturity," similar to the classic "bathtub" curve shown conceptually in Figure 3.2.

A review of Table 3.18 indicates that the aging failure percentage in the following systems and components slightly increased or remained constant past the 5 year mark:

- instruments and controls system
  - governor
- fuel system
  - injector pumps
- cooling system
  - pumps
  - piping
- starting system
  - controls
  - starting motors
- lubrication system
  - pumps
- intake and exhaust system
  - turbochargers
- generator system
  - generator
- switchgear system
  - relays.

Changes in failure modes indicate that failure causes in the <5-year category differ somewhat from failure causes later in plant life. Many components from the 5-year and older group, including the Cooling System pumps, Starting System controls, and the Lubrication System pumps, experience changes in failure causes. The Cooling and Lubrication System pumps showed an increase in degradation due to vibration, while the Starting System controls seemed to become more prone to maintenance induced failures. Similar changes occurred for several other components.

From a detailed review of the failure frequencies, failure causes, and affected components one could speculate that a curve similar to Figure 3.2 may be developed in terms of the aging failure percentage and may contain three

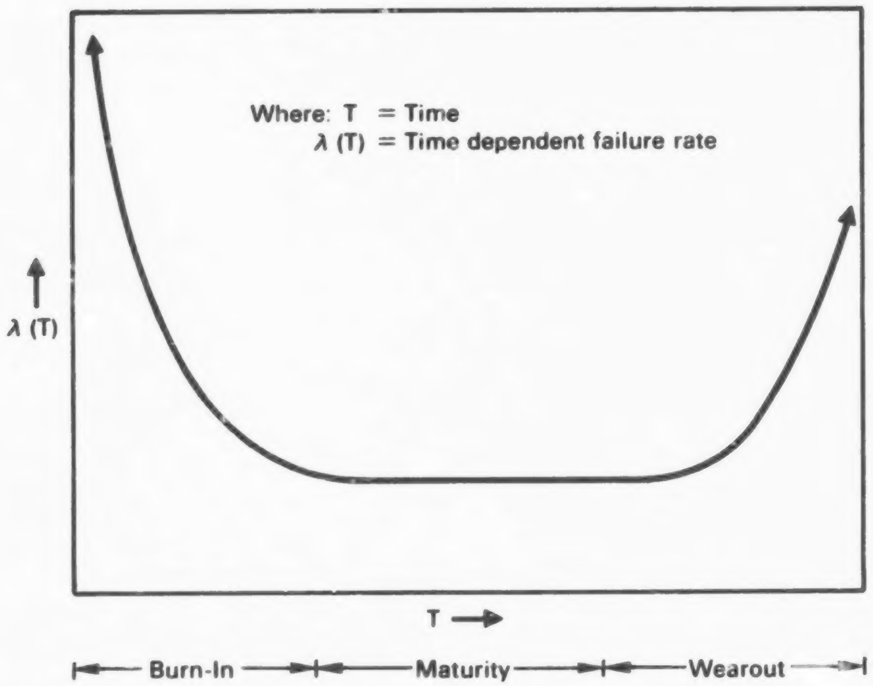

FIGURE 3.2. Change in Failure Rate Over Time

curves. Figure 3.3 shows the aging failure percentage curve defined as the composite of "burn-in", time-independent, and time-dependent aging failure percentages.[a] Although similar in form, the curve in Figure 3.3 is independent of the overall failure rate curve in Figure 3.2.

A general review of the aging failure data, including the component/failure-cause matrices and various computer sorts of associated failure comments, indicates that manufacturing, construction, and poor design problems tend to be reconciled early. These failures can then be attributed to the "burn-in" curve of Figure 3.3. Time-independent causes of aging failure tend to be maintenance, operation, and maladjustment/misalignment induced degradation. Time-dependent causes of aging failure tend to be adverse conditions (e.g., vibration and shock) and adverse environment (e.g., dust, chemical exposure, etc.).

Differentiating among the three aging failure curves is complex for two main reasons. First, the time (T) in Figures 3.2 and 3.3 is unknown for many components. This results in the overlay of aging failure curves, so averaging tends to level the curve. Second, differentiating between aging and non-aging failures is subjective.

---

(a) See the definition of aging failure percentage in Section 1.5.

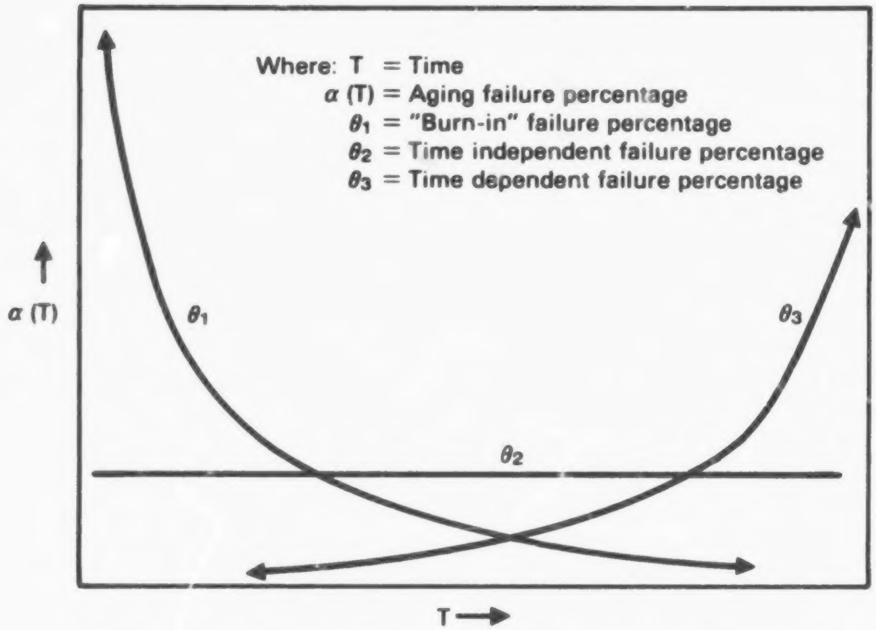
Where: T = Time
α (T) = Aging failure percentage
θ1 = "Burn-in" failure percentage
θ2 = Time independent failure percentage
θ3 = Time dependent failure percentage
α (T)
θ1
θ3
θ2
T

FIGURE 3.3. Composite Aging Failure Percentage Curve

As an example of the problem of differentiating between failures, assume that a heat exchanger failed within 1 year of operation. Upon inspection, a poor weld was found. The broken weld allowed internal components to vibrate and fail. The root failure cause could be regarded as poor construction (nonaging). If the failure occurred in 10 years, even though the design life was 40 years, the same failure might be attributed entirely to vibration (aging stressor) or an unanticipated condition, even though the root cause was still a poor weld and not vibration. A review of the secondary causes of failure in this study shows that the PNL NPAR diesel-generator staff tended to evaluate the root cause (for the hypothetical heat exchanger) as a manufacturing defect that eventually--and abnormally--failed, due to normal levels of vibration (therefore, manufacturing induced aging). This is an important point to consider when evaluating data and defining the shape of the curves, differentiating among $\theta_1$, $\theta_2$, and $\theta_3$ events in Figure 3.3.

Figures 3.4, 3.5 and 3.6 compare aging failure percentages for three failure causes: vibration, adverse environment, and poor manufacturing and construction quality control, respectively. Elements of the postulated shapes of Figure 3.3 are evident, although the lack of data makes quantification difficult (see Section 3.4.4).

### 3.4.3 Group III Matrices: Engine Systems

Most of the manufacturers supply engines to several contractors who upgrade the basic engine systems (many are of standard commercial quality) to

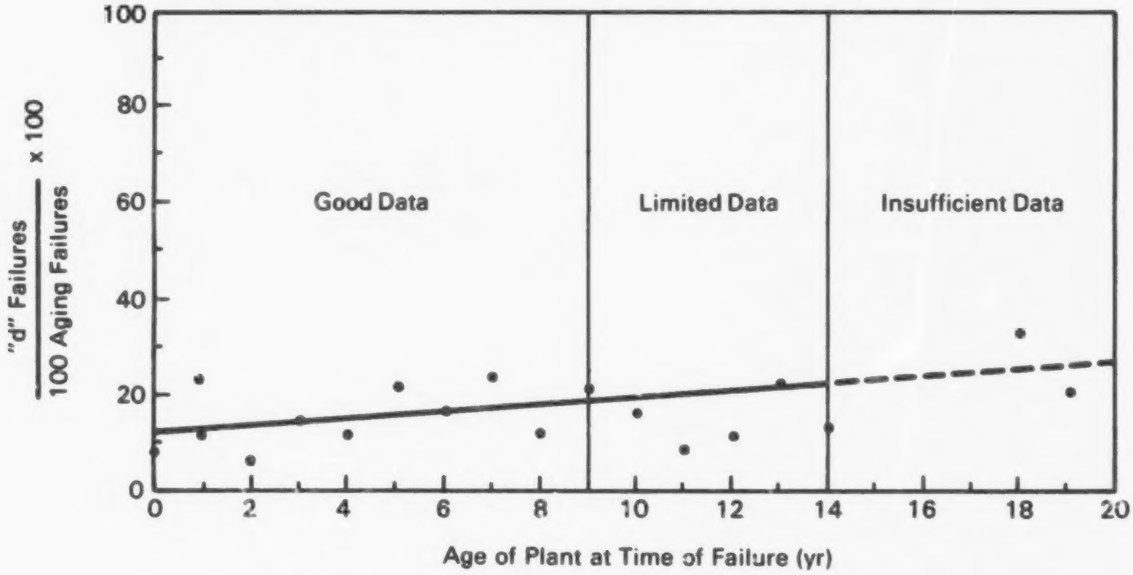

FIGURE 3.4. Vibration Induced Failures with Age

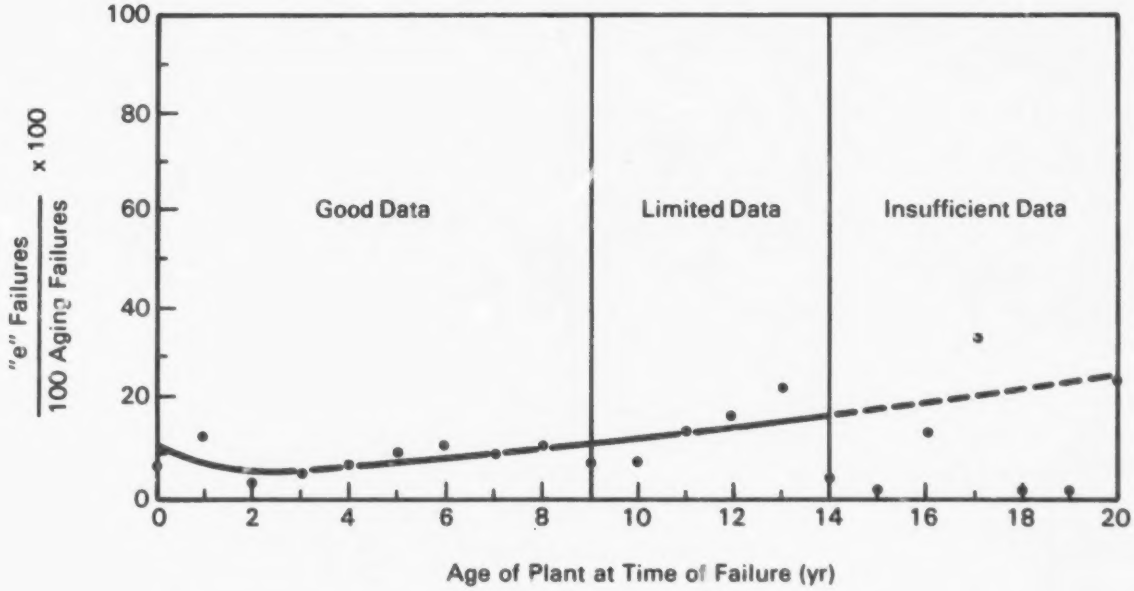

FIGURE 3.5. Environmentally Induced Failures with Age

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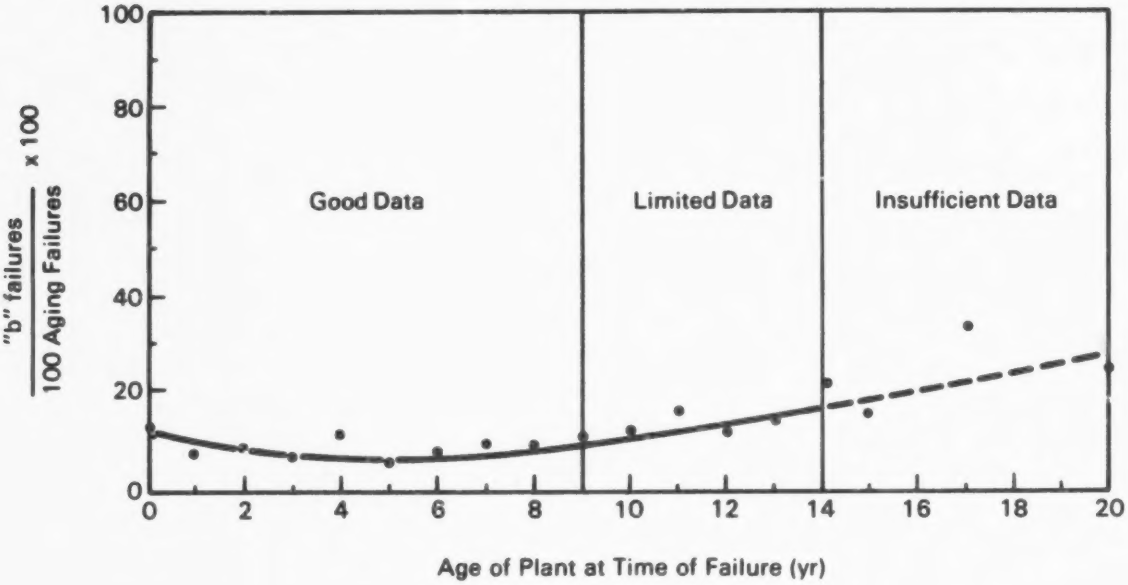

FIGURE 3.6. Manufacturing-Quality-Induced Failures with Age

meet current regulatory, code, and utility performance requirements. Examples of modifications undertaken by the "jobbing" contractor include the addition of redundant air start motors, spring-loaded injector racks, and crankshafts supplied with Certified Material Test Reports (CMTRs). A quality assurance package is also implemented to ensure conformance to existing regulations.

The intent of this section is to identify potential aging problems that may be isolated to a particular type of engine system. Due to the complex process of supplying an engine system for final utility use, aging degradation associations with particular manufacturers must be viewed as subject to the limitations of available data. Engine systems have been segregated by manufacturer, but failures should not be associated solely with the manufacturer without a more rigorous and detailed analysis. The failure percentages are not absolute; they represent the distribution of aging failures, even if the overall failure percentage is small. Simply stated, if a system or component is going to fail because of aging degradation, the failure percentages indicate which system or component is most likely to fail. These failures do not represent any measure of the overall system reliability.

This section raises attention to systems and components of diverse design and material composition so that potentially problematic areas can be identified to guide future research. In many instances, a representative database was not available. The data from these failures were included for information purposes and may not represent actual performance histories.

### 3.4.3.1 Manufacturer Code 1 Failure Matrix

Out of 147 total Code 1 engine failures, 78 were attributed to aging. Table 3.19 shows the breakdown of failure modes (also see Table B.32, Appendix B).

The components most subject to aging degradation are listed in Table 3.20.

### 3.4.3.2 Manufacturer Code 2 Failure Matrix

Code 2 engines represent a very small fraction of engines in nuclear service. Table 3.21 shows the major failure causes derived from 7 aging related

TABLE 3.19. Causes of Code 1 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 22 |
| Poor manufacturing or construction quality control | 22 |
| Adverse Environment: dust, humidity, chemicals, etc. | 17 |
| Unknown | 15 |
| Human error - maintenance | 14 |
| Other | 10 |

TABLE 3.20. Systems and Components Contributing Most to Code 1 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[(a)] |
|---|---|---|---|
| Instruments and Controls | 36 | | |
| Governor | | 22 | f, d, e |
| Cooling System | 15 | | |
| Piping | | 9 | d, e |
| Fuel System | 14 | | |
| Fuel Oil Pumps | | 8 | f |
| Lubrication System | 8 | | |
| Heat exchangers | | 4 | e |
| Pumps | | 3 | e, b |
| Other Systems | 27 | | |

---

(a) See Table 3.3.

TABLE 3.21. Causes of Code 2 Diesel-Generator Failure Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse environment: dust, humidity, chemicals, etc. | 43 |
| Unknown | 29 |
| Human error - maintenance | 14 |
| Poor manufacturing and construction quality control | 14 |

failures of a total of 10 failures (also see Table B.34, Appendix B). These data, although probably not completely representative of engine Code 2 characteristics, are included for interest.

Table 3.22 shows the problematic components identified in this limited data set.

### 3.4.3.3 Manufacturer Code 3 Failure Matrix

Only a few engin[illegible]n the nuclear industry are supplied by the Code 3 manufacturer. Table 3.23 shows the breakdown of failure causes (see Table B.36, Appendix B) for 18 aging related failures of 25 total failures. Again, this is a very limited data set.

TABLE 3.22. Systems and Components Contributing Most to Code 2 Diesel-Generator Failure Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[(a)] |
|---|---|---|---|
| Instruments and Controls | 43 | | |
| Governor | | 14 | m |
| Linkages | | 14 | j |
| Startup system | | 14 | e |
| Cooling System | 14 | | |
| Piping | | 14 | m |
| Generator | 14 | | |
| Exciter | | 14 | b |
| Switchgear | 14 | | |
| Breakers | | 14 | e |
| Other Systems | 15 | | |

---

(a) See Table 3.3.

TABLE 3.23. Causes of Code 3 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Unknown | 33 |
| Poor manufacturing construction quality control | 17 |
| Adverse conditions: vibration, shock | 17 |
| Human error - maintenance | 17 |
| Other | 16 |

The systems and components most subject to aging degradation are shown in Table 3.24.

TABLE 3.24. Systems and Components Contributing Most to Code 3 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[a] |
|---|---|---|---|
| Instruments and Controls | 50 | | |
| Governor | | 22 | b, e |
| Cooling System | 33 | | |
| Pumps | | 27 | j, d, e |
| Other Systems | 17 | | |

(a) See Table 3.3.

### 3.4.3.4 Manufacturer Code 4 Failure Matrix

Table 3.25 shows the breakdown of major failure causes for Code 4 engines (see Table B.38, Appendix B) for 131 aging-related failure evaluations of 207 total failures.

TABLE 3.25. Causes of Code 4 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 35 |
| Poor manufacturing and construction quality control | 16 |
| Unknown | 16 |
| Human error - maintenance | 8 |
| Adverse environment: dust, humidity, chemicals, etc. | 10 |
| Other | 15 |

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Table 3.26 shows the systems and components most subject to aging degradation from the aging-related failure data.

TABLE 3.26. Systems and Components Contributing Most to Code 4 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes(a) |
|---|---|---|---|
| Instruments and Controls | 38 | | |
| Control air system | | 11 | d |
| Governor | | 11 | b |
| Sensors | | 7 | d, e |
| Fuel System | 13 | | |
| Piping on engine | | 9 | d, b |
| Lubrication System | 11 | | |
| Fitters | | 5 | b, d |
| Starting System | 8 | | |
| Starting air valve | | 4 | b |
| Engine Structure | 6 | | |
| Liners | | 4 | b, c, d |
| Other Systems | 24 | | |

---

(a) See Table 3.3.

### 3.4.3.5 Manufacturer Code 5 Division Failure Matrix

Table 3.27 shows the failure causes of Code 5 engines for nuclear service engines (also see Table B.40). From a total of 681 failures, 333 aging-related failures were sampled.

TABLE 3.27. Causes of Code 5 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 23 |
| Adverse environment: dust, humidity, etc. | 20 |
| Poor manufacturing and construction quality control | 19 |
| Unknown | 17 |
| Human error - maintenance | 8 |
| Other | 13 |

Systems and components most subject to aging degradation are shown in Table 3.28 (see Table B.40, Appendix B).

TABLE 3.28. Systems and Components Contributing Most to Code 5 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[a] |
|---|---|---|---|
| Instruments and Controls | 27 | | |
| Governor | | 15 | b, d |
| Relays | | 4 | d, e |
| Wiring and terminations | | 2 | d |
| Starting System | 17 | | |
| Starting motors | | 6 | e |
| Controls | | 5 | e |
| Starting air valve | | 3 | d, e |
| Cooling System | 12 | | |
| Heat exchangers | | 4 | b, e |
| Pumps | | 4 | d |
| Lubrication System | 8 | | |
| Pumps | | 4 | d, e |
| Heat exchangers | | 2 | b, e, m |
| Generator | | 7 | |
| Voltage regulator | | 3 | b, e |
| Generator | | 2 | m, e |
| Fuel System | 7 | | |
| Piping on engine | | 2 | d |
| Switchgear | 7 | | |
| Relays | | 3 | b, e |
| Other Systems | 15 | | |

---

(a) See Table 3.3.

#### 3.4.3.6 Manufacturer Code 6 Failure Matrix

Table 3.29 shows the failure causes for Code 6 engines derived from 274 aging-related failures of 533 total failures (also see Table B.42, Appendix B).

TABLE 3.29. Causes of Code 6 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 31 |
| Adverse environment: dust, humidity, etc. | 19 |
| Poor manufacturing and construction quality control | 12 |
| Unknown | 12 |
| Human error - maintenance | 9 |
| Other | 17 |

A listing of the systems and components most subject to aging degradation is presented in Table 3.30.

TABLE 3.30. Systems and Components Contributing Most to Code 6 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[a] |
|---|---|---|---|
| Instruments and Controls | 21 | | |
| Governor | | 9 | d, e |
| Fuel System | 19 | | |
| Piping on engine | | 7 | d |
| Injector pumps | | 5 | d, e |
| Injectors and nozzles | | 4 | d, e |
| Engine Structure | 14 | | |
| Crankcase | | 7 | d, i, e |
| Liners | 4 | d, m | |
| Intake and Exhaust Systems | 8 | | |
| Turbocharger | | 4 | b |
| Cooling System | 7 | | |
| Piping | 3 | d | |
| Lubrication System | 7 | | |
| Heat exchangers | | 1 | b, j |
| Lube oil | | 1 | e |
| Other Systems | 24 | | |

---

(a) See Table 3.3.

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### 3.4.3.7 Manufacturer Code 7 Failure Matrix

Code 7 engines had 47 aging related failures represented in Table 3.31 of 95 total failures, which shows the failure cause distribution (also see Table B.44, Appendix B).

Table 3.32 shows the systems and components most subject to aging degradation.

### 3.4.3.8 Manufacturer Code 8 Failure Matrix

For Code 8 engines, Tables 3.33 and 3.34 present 119 aging failures of 164 total failures. Table 3.33 shows the major failure causes associated with these engines (also see Table B.46, Appendix B).

TABLE 3.31. Causes of Code 7 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 38 |
| Adverse environment: dust, humidity, etc. | 17 |
| Maladjustment/misalignment | 15 |
| Unknown 11 | |
| Other 19 | |

TABLE 3.32. Systems and Components Contributing Most to Code 7 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[a] |
|---|---|---|---|
| Instruments and Controls | 34 | | |
| Alarms and shutdowns | | 9 | d |
| Control air | | 6 | d, e, j |
| Sensors | | 6 | b, d, g |
| Fuel System | 19 | | |
| Injector pumps | | 9 | b, d, e, m |
| Piping on engine | | 6 | d |
| Cooling System | 17 | | |
| Pumps | | 6 | |
| Heat exchangers | | 6 | |
| Other Systems | 30 | | |

---

(a) See Table 3.3.

TABLE 3.33. Causes of Code 8 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Poor manufacturing and construction quality control | 34 |
| Adverse conditions: vibration, shock | 24 |
| Poor design: wrong component or application | 12 |
| Adverse environment: dust, humidity, etc. | 9 |
| Other | 21 |

Table 3.34 describes the systems and components most subject to failure due to aging degradation for Code 8 engines.

TABLE 3.34. Systems and Components Contributing Most to Code 8 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[a] |
|---|---|---|---|
| Instruments and Controls | 24 | | |
| Governor | | 9 | b, d |
| Fuel System | 18 | | |
| Piping on engine | | 8 | b |
| Injector pumps | | 6 | b |
| Intake and exhaust | 11 | | |
| Turbocharger | | 7 | a, b |
| Cooling System | 11 | | |
| Intercooler | | 4 | b |
| Starting System | 8 | | |
| Starting air valve | | 7 | b, a, e |
| Engine Structure | 8 | | |
| Crankcase | | 3 | |
| Heads | 3 | a | |
| Drivetrain | 8 | | |
| Pistons | | 4 | b, a |
| Other Systems | 12 | | |

---

[a] See Table 3.3.

### 3.4.3.9 Manufacturer Code 9 Failure Matrix

Table 3.35 shows the overall failure causes associated with Code 9 engines (also see Table B.48, Appendix B). Only 4 engines are in nuclear service, providing 24 aging related failures for this database from 49 total failures recorded.

Table 3.36 shows the systems and components most subject to aging degradation.

TABLE 3.35. Causes of Code 9 Diesel-Generator Failures Due to Aging

| Failure Cause | Percent of Aging Failures |
|---|---|
| Adverse conditions: vibration, shock | 38 |
| Unknown | 21 |
| Poor manufacturing and construction quality control | 21 |
| Adverse environment | 13 |
| Other | 7 |

TABLE 3.36. Systems and Components Contributing Most to Code 9 Diesel-Generator Failures Due to Aging

| Systems and Components | Percent of Aging Failures | | Main Failure Cause Codes[a] |
|---|---|---|---|
| Instruments and Controls | 29 | | |
| Governor | | 13 | a, b, d |
| Linkages | | 13 | d |
| Fuel System | 21 | | |
| Injector pumps | | 8 | d, j |
| Injectors and nozzles | | 8 | b, e |
| Starting System | 21 | | |
| Starting air valve | | 13 | b, d, m |
| Other Systems | 29 | | |

---

(a) See Table 3.3.

### 3.4.4 Postulated Aging Model for Discussion

An interesting assumption can be made about the shape of the time-dependent aging failure percentage. Figure 3.3 shows $\theta_3$ proceeding exponentially without bounds, but this is not realistic. Diesel-generator systems are finite, with a limited number of systems and components susceptible to aging degradation. Since many components will fail at times far beyond their expected lives, these aging-related failure modes do not affect the failure curves for equipment failing within the design life. As a result, a limited number of aging degradation failures ($\theta_3$) may proceed asymptotically toward a failure limit (that can never be 100% of all failures) as shown in Figure 3.7. If this is the case, the shape of the aging failure percentage curve ($\theta_3$) could represent a cumulative distribution function whose shape resembles an integrated probability density function of the percent change in aging failure percentages (derived from Collins 1981):

$$\alpha(T) = \int_0^{T_1} \frac{1}{\sqrt{2 \Pi \sigma}} \, e \exp \left[ -\frac{1}{2} \left( \frac{T-\mu}{\sigma} \right)^2 \right] dT$$

where $\alpha$ is the standard deviation, $\mu$ is the mean, and T is time.

The shape of the curve and the percentage of failures due to aging are bounded by the limits of the physical system they represent. If human intervention eliminates modes of failure through preventive maintenance, replacement of critical components, and improved maintenance practices and testing, the failure percentage limit ($\alpha_L$) will decrease. The resulting change in aging limit is shown in Figure 3.8. If human intervention generates more aging failure modes through incorrect, careless maintenance, or the installation of substandard parts, a corresponding and similar increase in the aging failure percentage limit ($\alpha_L$) will occur.

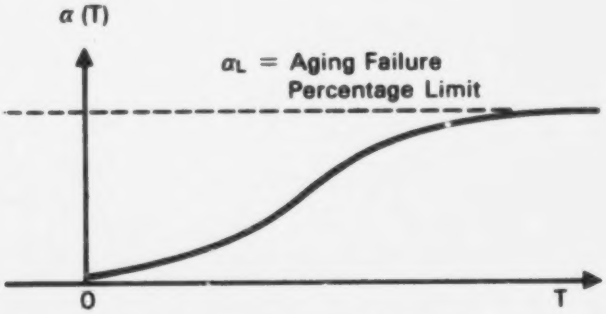
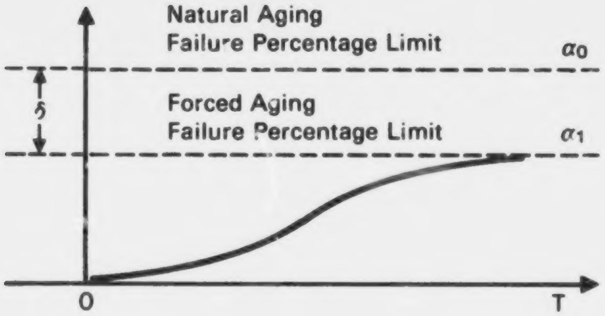


FIGURE 3.7. Cumulative Aging Failure Model



Where: $\alpha$ (T) = Time dependent failure percentage
T = Time
$\delta$ = Reduction of $\alpha$ (T) due to maintenance, etc.
$\alpha_L$ = Failure percentage limit

FIGURE 3.8. Cumulative Forced Aging Failure Model

A simple explanation for the forms of aging degradation failure curves and the significance of Figures 3.7 and 3.8 follows: past a certain point, as more aging failures occur and root cause corrections are made, less failures can occur because fewer things can go wrong. The "certain point" is the inflection point. When differentiated, it represents the maximum aging failure percentage change due to aging degradation. Trending of failure data may provide an early indication of the point of maximum aging failures. If the trending is done, and if the postulated failure model is accurate, a theoretical determination of component aging failure limits may be possible that is independent of the overall failure rate. Development of this model could be an important contribution toward justifying life extension decisions at nuclear facilities.

Another important perspective is the idea that $\theta_1$, $\theta_2$, and $\theta_3$ of Figure 3.3 are not necessarily the same order of magnitude and are not additive. Different systems and components may have a range of combinations representing the shape of $\theta_1$, $\theta_2$ and $\theta_3$. Obviously, any one of the three curves could then mask the other two. For example, a high time-independent aging failure percentage ($\theta_2$) could mask a time-dependent aging failure percentage ($\theta_3$) for many years unless a methodology was used to accurately differentiate between the two plots. In a worst case scenario, $\theta_3$ could seem to appear suddenly, resembling a step function: $\theta_3$ increasing late in life, when $\theta_3$ was actually progressing--unrecognized--steadily over time, masked by and confused with $\theta_2$ failure modes.

Representative data do not currently exist that can validate the proposed model. During the remaining phase of this NPAR diesel-generator study, data will be derived that are useful to model aging degradation and that help differentiate among failure types ($\theta_1$, $\theta_2$, and $\theta_3$).

### 3.4.5 Preliminary Recommendations

Appendix C shows the component/recommended corrective-action matrices. These matrices were formulated by including a primary and secondary recommended corrective action for each failure evaluated by the PNL NPAR staff. The matrices provide a general indication of efforts that should be made to correct aging related failures of diesel generators.

Ten categories of recommended corrective actions are listed below:

| Code | |
|---|---|
| a | Maintenance - realignment, adjustment |
| b | Repair - welding, grinding |
| c | Replacement: same type of component |
| d | Replacement: new or upgraded type of component |
| e | Redesign |
| f | Enhanced surveillance |
| g | Changes to operating conditions, parameters, environment |
| h | Enhanced training, management, records |
| i | Enhanced preventive maintenance |
| j | Unknown/none |

Examination of the matrix for aging related failures reveals the recommended corrective actions provided in Table 3.38. This shows that the majority (78%) of aging failures can be corrected by replacement of the aged part or by some form of maintenance activity such as realignment or readjustment.

A review of the component/corrective action matrix for components most susceptible to aging degradation reveals the following corrective actions, which are listed in Table 3.39.

TABLE 3.38. Summary of Most Common Recommended Corrective Actions

| Code | Recommended Corrective Action | Percent of Aging-Related Failures[(a)] |
|---|---|---|
| c | Replacement: same type of component | 52 |
| a | Maintenance - realignment, adjustment | 26 |
| d | Replacement: new or upgraded type of component | 13 |
| b | Repair - welding, grinding | 5 |
| i | Enhanced preventive maintenance | 2 |
| c | Redesign | 1 |

---

(a) From 1064 aging failures.

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TABLE 3.39. Summary of Corrective Actions for Components Most Susceptible to Aging

| Systems and Components | Corrective Action Codes[a] |
|---|---|
| Instruments and Controls | |
| Governor | c, a |
| Fuel System | |
| Injector pumps | c, d |
| Piping on engine | c, d |
| Starting System | |
| Controls | a, c |
| Starting air valve | a, d |
| Starting motors | c |
| Cooling System | |
| Pumps | c |
| Piping | e |
| Heat exchangers | c, a, b |
| Lubrication System | |
| Pumps | c |
| Heat exchangers | c |
| Intake and Exhaust | |
| Turbocharger | c |
| Engine Structure | |
| Crankcase | c |
| Liners | d |

---

(a) See Table 3.4 for code definitions.

Only liners, pistons, and starting air valves were identified as needing replacement by a new or upgraded part. The remaining systems and components shared recommended corrective actions similar to the overall recommendations for all categories of components. This implies that over half of all aging related failures can be prevented by regularly replacing or repairing only a few major components.

A review of the secondary recommended corrective actions shows that recommendations for enhanced maintenance training, preventive maintenance, and management directly complement primary corrective actions. For example, the secondary corrective action for vibration loosening was usually enhanced preventive maintenance.

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This leads to some interesting comparisons about how engine systems are maintained in nuclear versus non-nuclear service. Engines in non-nuclear service tend to be run continuously (and thus have few startups) or experience a slower warmup and loading period and therefore have fewer failures from system startup cycling. Additionally, engines used in non-nuclear service are usually the main source of energy for a particular application. Therefore, the engines receive direct, fulltime care through attentive maintenance and repair practices.

Throughout the course of this research, an interesting perspective between nuclear and non-nuclear maintenance practices has developed. Through numerous conversations, the general impression left with our research team was that the formalized structure surrounding maintenance activities in a nuclear facility prohibited the casual "mothering" of operating systems. In non-nuclear situations, these casual repairs to diesel systems, performed as needed, were viewed as a necessary activity, needed to remedy minor operational problems such as loose fasteners, fittings, etc. Usually, individuals, that are assigned fulltime, casually monitor and "tinker" with the system, making minor repairs as they become necessary. In a nuclear facility, the fear of tampering with a safety-related component as sensitive as the diesel-generator system tends to cause mechanics to stay away from the unit unless a formal work order is issued.

The lack of personalized attention to the diesel generator, within the formalized structure of the nuclear industry, may contribute to failures due to relatively minor problems such as oil leaks, vibration loosening of minor fittings, etc. It is expected that future, more detailed examinations of operating and regulatory practices will shed some light on this potentially limiting behavior.

Figure 3.7 shows the postulated aging model for time-dependent degradation. It would be interesting to observe the change in the aging failure percentage $[\alpha(T)]$ with an aggressive repair/replacement program centered on the results of performance/trend analysis and fulltime maintenance personnel. Thus, a form of success analysis may be useful to interpret data from specific plants for which maintenance programs have been optimized by experience.

As a result of this interim assessment of aging degradation, from operating and expert opinion, we are proposing the following preliminary recommendations for the operation and maintenance of diesel-generator systems.

- Conduct an active trend analysis program.
    - Identify potentially problematic components early in component life.

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  - Employ the latest methods for on-line system monitoring and diagnostics.
  - Perform trend analysis for comparison of results.
  - Compare performance histories with similar installations, nuclear and non-nuclear.

- Develop a dedicated maintenance program.
  - Promote rigorous utility technical training.
  - Dedicate personnel to the diesel-generator systems, fulltime if necessary.
  - Combine the roles of diesel operator and mechanic/electrician where possible.
  - Maintain a basis for and a record of "success analysis" as well as failure analysis for similar systems and components. It is as important to know why another facility is doing well as it is to know what they are doing wrong.
  - Provide comprehensive maintenance training on fundamental topics such as techniques to combat vibration loosening, etc.
  - Develop a preventive and a predictive maintenance program that aggressively pursues optimal performance. Fight the "run-it-until-it-breaks" syndrome.

- Develop an aggressive design review/change program.
  - Quickly identify problematic systems and components for design changes.
  - Make design changes as they are identified.
  - Review the design changes implemented throughout the industry for potential problems, and act on them before the problems occur.

- Increase vendor/contractor communications.
  - Conduct and participate in industry workshops and seminars.
  - Ensure that the technical information (i.e., controlled technical manuals) is correct and maintained for the installed units.
  - Ensure that new technical information from all sources is delivered to a responsible person and that a time frame for action is established for each task.

# 4.0 EXPERT OPINION

Aging is a concern for all mechanical and electrical components because every part is affected to some extent by stressors during both service and outages. Even though the diesel generators at nuclear power plants are operated only periodically, they must be able to maintain their operational readiness despite possible aging degradation.

## 4.1 APPROACH

Concerns regarding aging problems of medium- to-large-bore, medium-speed diesel generators installed at domestic nuclear plants were addressed in a workshop conducted by PNL staff and several diesel engine consultants. These consultants are:

- J. E. Horner, Seaworthy Systems Inc., B.S.M.E., University of Bridgeport. Twenty-two years of experience in the field of marine diesels. Manager of Marine Design and principal investigator on diesel engine field surveys, evaluations and performance analyses.

- B. J. Kirkwood, Covenant Engineering. M.S. Engineering, Massachusetts Institute of Technology. Retired in 1982 as a senior partner of A. C. Kirkwood and Associates, where his responsibilities included diesel generator installation designs involving 19 engines of 5 makes, in sizes to 7000 kW. Familiar with engine design and operational considerations and realistic performance expectations. Is now consultant for clients on specific engine problems to determine causes and propose solutions.

- P. J. Louzecky, Engineered Applications Corporation. M.S.M.E., Case Western Reserve University. Nearly 50 years of experience in the design and development of gas and diesel engines of up to 11,000 kW. Specialist in engine and gear design and related lubrication technology. Performs consulting work on engines.

Additional information on these diesel engine consultants and their firms is provided in Appendix D.

Each component, part, or system identified in the component list was derived for analysis from a diesel generator with a nameplate rating of 3500 kW, operating at 450 rpm with a brake mean effective pressure (BMEP) of 225 psig. Diesel generators of this size and type are installed in many nuclear plants and were considered typical of diesel generators in nuclear service at the time of the workshop. Based on the consultants' expertise and the operational environments in nuclear plant services, the probability of component failure was evaluated and types of anticipated failures were defined.

The PNL workshop evaluation by diesel experts was completed before their review of actual operating experience data. Doing so provided expert opinion

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regarding operational failure that was based largely on non-nuclear experience. This approach provided a basis to compare nuclear and non-nuclear operational and failure mode data. Differences between non-nuclear and nuclear experience could be indicative of failure modes or mechanisms peculiar to the nuclear industry.

## 4.2 MECHANISMS AND EFFECTS OF AGING

The PNL workshop concentrated on having the consultants define the factors that affect the aging of diesel generators and their critical support systems and classifying the potential for component failures as high, medium, or low. A summary of the consultants' opinions, resulting from the workshop, and the anticipated failures caused by aging are shown in Table 4.1. From 99 categories of diesel-generator parts, components, or systems, it was the opinion of the diesel consultants that 32 had a high to medium probability of failure. The remaining 67 systems or components had a low probability of failure.

## 4.3 COMPONENTS SUSCEPTIBLE TO AGING

The components or systems considered by the diesel consultants to have a high to medium probability of aging while in service at a nuclear facility include:(a)

- engine structure
  - main bearings
- drive train
  - camshaft
  - connecting rod bearings
- valve mechanisms
  - intake and exhaust valves
- starting components
  - starting air distributor
  - air start valves*
  - strainers and filters
  - relief valves on tank
- intake and exhaust
  - air filter
  - turbo charger
  - exhaust manifold flex joint

---

(a) The "*" indicates agreement with the abbreviated results of the component/failure-cause matrices presented in the tables of Section 3.

- instruments and controls
  - governor*
  - overspeed governor*
  - control valves
  - alarms and shutdowns
  - wiring and terminations

- electrical systems
  - switches
  - contacts in control panels*

- fuel components
  - injector pumps*
  - piping on engine*
  - injectors and nozzles*

- lubrication components
  - lube oil heater*

- cooling components
  - intercooler*
  - jacket water stand pipe heaters

- generator components
  - rotor
  - exciter
  - voltage regulator

- mechanical system
  - piping valves.

A review and comparison of the results presented in Table 4.1 and the results of the component/failure-cause matrices show some differences between the failures projected by the consultants and the results of the nuclear EDG aging database. The consultants tended to identify aging degradation for components that did not show a significant number of failures due to aging. This could indicate that these failures may begin to appear as plants age. Additionally, the tables in Section 3.0 show the normalized aging failures percentage of all failures, whereas the consultants identified the total potential for failure. A close comparison of Table 4.1 and the matrices in the Appendix show a good correlation between expected failures and recorded failures.

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## TABLE 4.1. Aging Failure Matrix (based on expert opinion)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| Engine Structure | | | | |
| (a) Base assembly | L | | Overstressing, leading to misalignment | |
| (b) Crankcase | L | Sludge accumulation | Overstress | |
| (c) Cylinder block | L | Water corrosion | Cylinder head pounding, overstress | |
| (d) Heads | L | Incorrect water treatment | Thermal distortion--valve seat cracking; overstress | Valve failure |
| (e) Main bearings | M | Corrosion due to oil breakdown | Wear-cavitation, metal contact wear, brinelling due to set (no motion for long time); erosion from dirt in oil; improper stud torque | Electrolysis; water contamination of lube oil |
| (f) Liners | L | Oxidation, corrosion, water leaks | Wear on fast starts; stuffing, cavitation erosion due to vibration | Cooling design distortion |
| (g) Other | L | | Subcover fatigue due to vibration and/or overtorquing of fasteners | |
| Drive Train | | | | |
| (a) Crankshaft | L | Oil hole plugging; corrosion of thrust bearings rings due to oil breakdown | Wear, fatigue, vibration mechanical deflection due to foundation/shaft relative alignment. Lack of thermal stability due to test procedure (fast startup or cooldown stresses), overstress due to operation through critical speeds. Wear/cavitation, metal contact wear of thrust bearing rings | Electrolytic |
| (b) Connecting Rods and Bushings | L | Improper oil, dirt in oil | Fretting due to loosening causes wear of bolts (except certain engine models), overstress | |

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## TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure |  |  |
|---|---|---|---|---|
|  |  | Chemical | Mechanical | Other |
| (c) Pistons | L | Corrosion of piston pin assembly due to oil chemistry | Two piece piston--mechanical breakdown. Burning of crown if incorrect nozzle spray pattern. Lack of lubricant or cooling. Wear, scuffing and breakage of piston rings |  |
| (d) Gears | L |  | Backlash, impact loading torsimal vibration, overstress |  |
| (e) Camshaft | M |  | Cam wear due to high load and lack of oil; cam shifting on shaft; vibrations |  |
| (f) Flywheel | L | Fretting corrosion of bolting | Vibrating torque producing pounding, overstress of bolts |  |
| (g) Connecting rod bearings | H | Corrosion due to oil chemistry; water contamination | Dirt in oil causes wear, fatigue of shell and babbit metal, loss of or oil depletion. Cavitation if oil pressure and feed system are inadequate | Electrolysis due to stray and static currents |
| (h) Other | L | Gasket deterioration | Oil leaks, gasket working, deterioration |  |
| Valve Mechanisms |  |  |  |  |
| (a) Pushrods | L | Corrosion due to oxidation products from oil breakdown | Busing wear due to dirt in lubricant |  |
| (b) Rocker arm assembly | L | Corrosion due to oxidation products in oil | Wear due to dirt in lubricant; carbon erosion from exhaust blowby; lack of oil |  |
| (c) Intake and Exhaust Valves | M | Chrome plate flaking | Service wear, fretting, valve seat erosion; Stellite may crack and cause torching, melting; high thermal transients and fatigue of springs and retainers | Valve head distortion leading to poor seating |
| (d) Other | L |  |  |  |

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## TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| **Starting Components** | | | | |
| (a) Starting air distributor assembly | H | Corrosion due to moisture | Wear due to distribution plates rubbing against each other. Plugging with corrosion products | Maintenance and reassembly |
| (b) Air start valves | H | Corrosion products from water contamination | Fouling due to air system contamination (dirt, corrosion products). Incorrect adjustment | |
| (c) Air compressors | — | | | |
| (d) Controls | — | | | |
| (e) Barring device | L | Corrosion due to moisture in air | | |
| (f) Strainers and filters | M | Corrosion due to moisture in manifold | Plugging due to corrosion products | |
| (g) Tank | L | Corrosion due to condensate formation | | |
| (h) Starting motors | — | | | |
| (i) Other | H | Corrosion of relief valve from tank | Sticky valves from dirt; rust; plugging of air float trap | Air float trap seat failure from poor materials |
| **Intake and Exhaust** | | | | |
| (a) Air filter | M | | Environmental conditions can affect condition (e.g., outside air with foreign material, sea water, snow, etc.) | |
| (b) Turbocharger | H | Corrosion (IGSCC). Corrosion of tri-metal bearings due to oil breakdowns | Design mechanical stresses on casing, plugging of vanes, installation, bearing lubrication loss | Thermal: due to design, thermal: due to loss of lubrication |
| (c) Silencer (muffler) | L | | | |

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TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| (d) Other | H/M | | Exhaust manifold flex joint failure due to carbon fouling | Leakage at joint into turbocharger can produce carbonization of slip rings |
| | L | | Vibration damage of turbocharger piping, fittings, couplings, supports; wear of turbocharger lube system due to loss of lubrication | |
| Instruments and Controls | | | | |
| (a) Governor | H | Corrosion due to oil deterioration | Loss or insufficient oil, inadequate venting, maladjustment, torsional vibration | |
| (b) Overspeed governor | H | Coupling deteriorated, governor becomes oxidized, gasket seal deterioration | Engine vibration leading to bolt loosening causing linkage to slip. Vibration loosening/out-of-adjustment | |
| (c) Control valves | M | | Poor lubrication of butterfly valve closure | |
| (d) Alarms and shutdowns | H | | Dirty contacts, poor calibration, hydraulic liners become fouled | |
| (e) Linkages | -- | | | |
| (f) Startup system | -- | | | |
| (g) Control air system | -- | | | |
| (h) Wiring/terminations | M | Oxidation, oil deterioration | Vibration loosening of connections; short circuits | |
| (i) Relays | -- | | | |
| (j) Sensors | | see (d) above | | |

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## TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| (k) Other | H | Corrosion of governor assembly Heat exchangers | Leak due to vibration of governor assembly and heat exchanger | |
| | H | Oxidation of thermocouples | Thermocouple vibration loosening, shortcut or open circuit, thermal cycling damage | |
| Electrical Systems | | | | |
| (a) Switches | H | Oxidation, oil deterioration | Vibration; improper adjustment | |
| (b) Wiring, conduits, etc. | L | | | |
| (c) Transformers | — | | | |
| (d) Controls | — | | | |
| (e) Other | H | Oxidation of contacts in control panel devices | Clogged air lines, coil burnouts in control panel | |
| Unrelated to EDG | | | | |
| (a) Manual shutdown | — | | | |
| (b) Other | — | | | |
| Fuel Components | | | | |
| (a) Injector pumps | M | Varnish buildup from deteriorated fuel oil | Stuck plungers from dirt/particles | |
| (b) Filters, strainers | L | Material deteriorates (chemical effect on some material), water in fuel oil | Clogging due to dirt and sludge. Lack of uniformity in filter design/manufacturing | |
| (c) Fuel oil pumps | L | | | |
| (d) Oil storage | L | Oxidation, varnish, paraffin or gum buildup in day tank | | Biological growth |

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TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| (e) Piping on engine (fuel injection tubing) | M | | Vibration leaks at fittings, high cycle fatigue, erosion problems, cavitation at small pipe radius | |
| (f) Injector and nozzle | M | Varnish buildup | Stuck needle valves due to dirt/particles; hole erosion | Coking of fuel in end |
| (g) Fuel | L | | | Bacteria in fuel oil |
| (h) Other | M | | Sticking of fuel pump linkage shaft and bearings due to no lubrication, heat, or dust in air | |
| Lubrication Components | | | | |
| (a) Pumps | L | | Engine-driven pump vanes or gears will wear, pressure surges, shaft coupling breakage | |
| (b) Filters | L | | | Water in oil can clog |
| (c) Strainers | L | | | Water in oil can clog |
| (d) Heat exchangers | L | Tube pitting due to corrosion | Vibration | |
| (e) Control valves | L | | Fatigue of springs; plugging with foreign material | |
| (f) Piping | L | | Vibration cracking, loosening, leakage | |
| (g) Lube oil | -- | | | |
| (h) Other | M | | Carbon buildup on lube oil heater forms heat transfer barrier and heaters run hotter (electric heaters) | |

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## TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| **Cooling Components** | | | | |
| (a) Pumps | L | | Wear of wear rings and cavitation of impeller; mechanical seal goes dry | |
| (b) Heat exchangers | L (unless seawater then H) | Pitting corrosion, water corrosion | | Biofouling if seawater; silt and slime if freshwater |
| (c) Intercooler | M | Chemical attack from water chemistry | Erosion, fouling, vibration induced pinhole leaks, plugging | |
| (d) Radiator | -- | | | |
| (e) Cooling tower | -- | | | |
| (f) Piping | L | Oxidizing ozone, heat deterioration of coupling seals and supports | Gasket deterioration and leakage; vibration loosening | Deterioration of o-rings from thermal and thermal gradient effects |
| (g) Cooling water | (see b (above) | | | |
| (h) Other | M | Certain models of jacket water standpipe heaters are susceptible to water corrosion | | |
| **Generator Components** | | | | |
| (a) Generator (rotor, stator, frame) | M | Insulation, varnish | Brush wear, plugging of cooling holes, electric overload damage to coils, overspeed damage to rotor | Aging of lashing, delamination |
| (b) Exciter | H | Contact burnout, contact oxidation, insulation, breakdown | Vibration | Burnout of diodes-heat sink loss; voltage spikes |
| (c) Voltage regulator | H | Contact burnout, contact oxidation, insulation, breakdown | Vibration | Burnout of diodes-heat sink loss; voltage spikes |
| (d) Pedestal bearings | L | Lubricant contaminants | Wear/lubrication, misalignment | Stray currents |
| (e) Other | -- | | | |

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## TABLE 4.1. (contd)

| System and Component | Component Failure Potential | Type of Failure | | |
|---|---|---|---|---|
| | | Chemical | Mechanical | Other |
| **Switchgear Components** | | | | |
| (a) Breakers | L | Contact oxidation | | Arcing |
| (b) Relays | — | | | |
| (c) Instruments and controls | | See electr. systems | | |
| (d) Other | H | | Grit and moisture fouling of cabinet/system | Inadequate ventilation leads to overheating |
| **Structural Components** | | | | |
| (a) Engine foundation | L | Concrete foundation deterioration or settling | Foundation cracking | Thermal effects on foundation may affect crankshaft alignment |
| (b) Rails, chocks, grout, etc. | — | | | |
| (c) HVAC | — | | | |
| (d) Drainage of waste | — | | | |
| (e) Other | — | | | |
| **Mechanical Systems** | | | | |
| (a) Valves | M | Corrosion | Seat wear, leakage | |
| (b) Piping and fittings | L | Corrosion | Leakage, loosening due to vibration; flex coupling leakage; fatigue and temperature problems | |
| (c) Piping supports | — | | | |
| (d) Other | L | Oxidation, corrosion | Vibration loosening of gaskets, joints | Assembly, disassembly of systems affects performance |

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# 5.0 DISCUSSION OF CURRENT REQUIREMENTS

This chapter provides an overview of current NRC regulations and guidance and the related codes and standards for designing, installing, and operating emergency diesel generators at U.S. commercial nuclear stations. The purpose of this chapter is to establish an understanding of the underlying regulations, codes, standards, and problems aimed at establishing and sustaining EDG reliability. This section contains the following subsections: 1) selection, design, and qualification; 2) testing; 3) modification and reporting ; and 4) failure/deficiency notification.

## 5.1 SELECTION, DESIGN, AND QUALIFICATION

### 5.1.1 NRC Criteria

10 CFR 50's General Design Criterion 17 (GDC-17), "Electric Power Systems," requires an onsite electric power source system to permit functioning of structures, systems, and components important to safety (see page 2.1).

Utilities meet the requirements of GDC-17 by installing EDGs. Generally the EDGs are installed in accordance with NRC Regulatory Guide 1.9, "Selection, Design and Qualification of Diesel-Generator Units Used as Standby (On-Site) Electric Power Systems at Nuclear Power Plants." This regulatory guide incorporates IEEE Standard 387-1977,(a) "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," which delineates principal design criteria and qualification testing requirements that, if followed, will help ensure that EDGs will meet performance and reliability requirements.

These basic design criteria (GDC-17), regulatory guidance (Regulatory Guide 1.9), and industry guidance (IEEE 387-1977) are supported and extended by other NRC design guides, regulatory guides, and staff technical positions. These sources are identified in Table 5.1, which is adapted from the NRC Standard Review Plan (NUREG-0800). It is noteworthy that GDC-2 and GDC-4 mandate that the diesel generator must be protected against natural phenomena (e.g., seismic occurrences, flooding, winds, etc.) and accidents such as fires and missile impingement.

The diesel generator, as Class 1E equipment, is subject to 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants." Accordingly, utilities are required to submit environmental specifications (temperatures, pressure, humidity, chemicals, radiation, aging, and synergistic effects) that would apply to diesel-generator operations. The EDGs must then be shown to be qualified under these conditions. In

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(a) While there is a more current revision of this IEEE standard (IEEE Standard 387-1984), the NRC Regulatory Guide has not yet been updated to incorporate it.

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## TABLE 5.1. Acceptance Criteria and Guidelines for Onsite Electric Power Systems

| Criteria | Title |
|---|---|
| General Design Criteria (GDC) | |
| GDC 2 | Design Bases for Protection Against Natural Phenomena |
| GDC 4 | Environmental and Missile Design Base |
| GDC 5 | Sharing of Structures, Systems, and Components |
| GDC 18 | Inspection and Testing of Electrical Power Systems |
| GDC 50 | Containment Design Bases |
| Regulatory Guides (RGs) | |
| RG 1.6 | Independence Between Redundant Standby (On-Site) Power Sources and Between Their Distribution Systems |
| RG 1.32 | Use of IEEE Standard 308, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations" |
| RG 1.47 | Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems |
| RG 1.63 | Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants |
| RG 1.75 | Physical Independence of Electric Systems |
| RG 1.81 | Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants |
| RG 1.106 | Thermal Overload Protection for Electric Motors on Motor-Operated Valves |
| RG 1.108 | Periodic Testing of Diesel Generators Used as On-site Power Systems at Nuclear Power Plants |
| RG 1.118 | Periodic Testing of Electric Power and Protection Systems |
| Branch Technical Positions (BTPs) | |
| BTP ICSB 4 | Requirements on Motor-Operated Valves in the ECCS Accumulator Lines |
| BTP ICSB 18 | Application of the Single Failure Criterion to Manually Controlled Electrically Operated Valves |
| BTP ICSB 21 | Guidance for Application of RG 1.47 |
| BTP ICSB 21 | Adequacy of Station Electric Distribution System Voltages |
| BTP PSB-2 | Criteria for Alarms and Indications Associated with Diesel-Generator Unit Bypassed and Inoperable Status |
| NUREG Reports | |
| NUREG/CR-0660 | Enhancement of On-site Diesel-Generator Reliability |

addition to ambient environments, 10 CFR 50.49 also requires that the EDGs be qualified for operations under environmental conditions that could prevail during pipe breaks, loss of ventilation, vibration from operations, and other events.

### 5.1.2 Industry Codes and Standards

A number of established industry codes and standards to which diesel-generator equipment and accessories must conform are incorporated in Regulatory Guide 1.9 via its reference to IEEE 387-1977. They include the following:

1. ANSI C50.5-1955, Rotating Exciters for Synchronous Machines
2. ANSI C50.10-1977, General Requirements for Synchronous Machines
3. ANSI C50.12-1965, Requirements for Salient Pole Synchronous Generators and Condensers
4. API Standard 650, Welded Steel Tanks for Oil Storage
5. ANSI C50.5-1955, Rotating Exciters for Synchronous Machines
6. ANSI C50.10-1977, General Requirements for Synchronous Machines
7. ANSI C50.12-1965, Requirements for Salient Pole Synchronous Generators and Condensers
8. API Std 650, Welded Steel Tanks for Oil Storage
9. DEMA, Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines
10. IEEE Std 115-1965, Test Procedures for Synchronous Machines
11. IEEE Std 308-1974, Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations
12. IEEE Std 323-1974, Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.

In addition to these standards, which are directly incorporated into NRC regulatory guidance, other codes and standards are approved in the design of nuclear station EDGs. Examples are given in Table 5.2.

### 5.1.3 Discussion

Generally the applicable design-related codes and standards are implemented by the engine manufacturer or the interfacing contractor for nuclear installation. Qualification codes are confirmed by the engine owners (utilities). There are currently areas of uncertainty in these generalizations. Before 1979 the Diesel Engine Manufacturer's Association (DEMA) Standard

## TABLE 5.2. Codes and Standards Not Directly Incorporated into NRC Regulatory Guidance

### Essential Elements of the Fuel Oil System Components

ANSI 195 (1976)

ASME Boiler and Pressure Vessel Codes (1974 Edition), Section III(a)

NRC Regulatory Guide 1.137 (1979)

### Nonessential Elements of the Fuel Oil System and All Components of the Auxiliary Systems (e.g., lube oil, starting air and jacket water systems)

ANSI B31.1, Power Piping (1973 Edition and Summer '74 Addendum)

ASME Boiler and Pressure Vessel Codes (1974 Edition), Section III(a)

### Diesel Engine and On-Engine Mounted Piping and Components

ASTM-A106

ASTM-A53

ANSI-B16.5

ANSI-B16.25

ANSI-B16.10

ANSI-B16.11

ANSI-B31.1

ASME Boiler and Pressure Vessel Codes (1974 Edition), Section III(a)

### Pressure Vessels

ASME Section VIII, Division I(a)

TEMA Class R for Lube Oil and Jacket Water Coolers

### Pumps

Hydraulic Institute Standards

### Generators

NEMA-MG-1-1972, Motors and Generators

ANSI-C-50.10-1965, General Requirements for Synchronous Machines

ANSI-C-50.12-1965, Requirements for Salient Pole Generators and Condensers

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(a) Only occasionally applied.

TABLE 5.2. (contd)

Motors

NEMA-MG-1-1972, Motors and Generators

Diesel Generators

IEEE Standard 308, Criteria for Class IE Power Systems for Nuclear Generating Stations

IEEE Standard 323, Standards for Qualifying Class IE Equipment for Nuclear Power Generating Stations

IEEE Standard 344, Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations

IEEE Standard 387, Criteria for Diesel-Generator Units Applied as Standby Power Supplier for Nuclear Power Generating Stations

Diesel-Generator Tests

IEEE Standard 115 (1983), Test Procedures for Synchronous Machines

ASME Performance Test Codes, PTC-17-1957 and PTC-26-1962

Practices were considered equivalent to ASME standards. This proved to be incorrect, and PNL has not yet determined the implications. Likewise, plants are currently implementing both the vibration qualifications and possibly elements of the environmental qualifications (EQs) required by 10 CFR 50.49. Completion of the EQs was required by November 30, 1985. Any engine modifications to meet these EQ requirements will likely have a bearing on engine reliability and may affect aging phenomena as well. Only occasionally are the ASME codes applied to portions of the diesel related systems.

## 5.2 TESTING

10 CFR 50's Criterion XI, "Test Control," requires that a test program be established to ensure that systems and components perform satisfactorily and that the test program include operational tests during nuclear plant operation. 10 CFR 50's Criterion 18, "Inspection and Testing of Electric Power Systems," requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing to assess component condition. Surveillance testing and inspections are also mandated by 10 CFR 50.55(a) for ASME Section III, Code Classes 1, 2 and 3 components, which include diesel generators.

NRC Regulatory Guide 1.108, "Periodic Testing of Diesel-Generator Units Used as On-site Electric Power Systems at Nuclear Power Plants," describes a method acceptable to NRC for complying with the regulations cited above. To

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meet established reliability goals, a preoperational and periodic test program was identified. The test, specified as preoperational and to be done at least once every 18 months, calls for:

- startup from simulated loss of offsite power signal
- demonstration of load sequencing
- run at load for 24 hours (2 hours at 10 percent overload)
- demonstrate load shedding capability
- hot restart and load sequencing
- demonstrate switching fuel oil supply systems
- demonstrate reliable starting.[a]

In addition to these tests, NRC guidance calls for monthly testing aimed at assuring engine operability. These monthly tests include:

- start up and confirm voltage and frequency attained within acceptable time limits (generally taken as less than 10 seconds to reach rated engine rpm without loading and 1 minute to attain generator rates load)
- run at engine rated load for at least 1 hour.

NRC guidance further provides that these monthly tests should be repeated more frequently if there are performance failures. The frequency interval is the inverse of the failure frequency, as shown in Table 5.3.

TABLE 5.3. NRC Regulatory Guide 1.108 Test Frequency

| Maximum Number of Failures in Last 100 Valid Tests | Recommended Test Interval, days |
|---|---|
| 1 | 31 |
| 2 | 14 |
| 3 | 7 |
| 4 | 3 |

Certain provisions of Regulatory Guide 1.108 are under review by the NRC. In particular, a proposal in Generic Letter 84-15 (July 2, 1984) requested industry response to changes in the monthly frequency of "fast" starts and in changes to the test interval associated with performance failures (Table 5.2). A consensus appears to be developing that the monthly starts should be "slow" starts, taking perhaps a minute or more to reach engine

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(a) The regulatory guidance calls for 23 or 69/n starts, whichever is larger, per diesel engine (where n is the number of identified diesel generators at the plant). Generally this condition is met during preoperational testing, and the monthly starts are added to these to calculate a "running" assessment of reliability.

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operating speed and a slow loading. Starts from simulated emergency conditions would be done at 6 month intervals and at refueling outages. Since "fast" starts are perceived to have a detrimental effect on engine performance, the new test conditions are expected to improve engine reliability. The reduced number of fast starts also may affect certain engine aging phenomena.

## 5.3 MAINTENANCE/REPAIRS

Section 5.2.2 of IEEE 387-1977 states that 1) inspections and scheduled maintenance shall be performed periodically using manufacturer's recommendations or procedures on operating experience, or both; and 2) unscheduled maintenance shall be performed in accordance with need as indicated by the periodic inspections as suggested by the manufacturer's recommendations or as based on operating experience, or both. NUREG/CR-0660, Enhancement of On-Site Emergency Diesel-Generator Reliability, also states that "better recognition should be given to the need and advisability of doing investigative testing, replacement, and adjustment as a part of preventive maintenance."

Some diesel engine components are supplied and maintained in accordance with ASME Sections III and XI. In particular, the rules of Section XI constitute requirements "to maintain the nuclear plant and return the plant to service... in a safe and expeditious manner." Such statements clarify the intent of the code; namely, that ASME Section III Class 1, 2 and 3 equipment should be maintained in a condition at least equal to the minimum design specifications required for safe operation of the nuclear plant. Although theoretically not harmful, the conservative requirements for maintenance, testing, and repair under the rules of Section XI are significantly more stringent and costly than those for engine systems in non-nuclear service. Generally, diesel engine systems have fallen under the auspices of Section XI, whose primary focus is reactor pressure boundary integrity, because regulatory pressures influenced construction to be in conformance with ASME III requirements. As a result, some utilities committed to a blanket Section XI coverage for all ASME III Systems and components, thereby entrapping engine systems into potentially mismatched and awkward compliance issues.

In accordance with these recommendations, the utilities conduct routine maintenance and surveillance (M/S) activities. Generally the manufacturer's owner's manual and ASME codes form the bases for M/S activities, with modifications based on experience. Both standby and operating surveillance plans are in place, and scheduled maintenance occurs daily, monthly, and during refueling. Complete engine teardowns are also routine at frequencies of about 5 years. The worth, extent, and adequacy of these M/S activities have not been evaluated.

Repairs or modifications to diesel engines in service are guided by IEEE-387-1977, Section 5.4, "Qualification," and Section 5.5, "Design and Application Considerations." In practice, the nuclear plant engineering group implements repairs and modifications via technical evaluation reports, nonconformance reports and repair/maintenance work orders. These are reviewed

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by the plant's quality assurance office to assure conformance with specifications with respect to applicable standards, codes, materials, repair procedures, etc.

## 5.4 FAILURE/DEFICIENCY/NONPERFORMANCE NOTIFICATIONS

The following subsections briefly discuss the three applicable regulations governing the reporting of diesel-generator component deficiencies or failures and failure of the EDG to perform expected functions.

### 5.4.1 10 CFR 21, "Reporting of Defects and Noncompliance"

The regulations of this part require equipment vendors to the nuclear utilities to report component defects that "could create a substantial safety hazard." In practice, Part 21 notices are routinely provided to NRC and are used to correct identified generic deficiencies.

### 5.4.2 10 CFR 50.55, "Conditions of Construction Permits"

The provisions of this part require holders of construction permits to notify the NRC of deficiencies that would adversely affect the safe operation of the nuclear plant. Diesel engine component failure and/or failures of the diesel engine to start, run, take load, or shed load are reported. Generally diesel engine testing is started well in advance of the fuel loading, so Part 50.55 provides early information regarding the diesel generators at nuclear plants before fuel loading. If Part 50.55 notification involves a component failure of a generic nature, NRC transmits this information to all affected engine owners.

### 5.4.3 10 CFR 50.73, "License Event Report System"

With respect to the EDGs, this serves the same function as Part 50.55 but applies to license holders.

## 5.5 DISCUSSION

The NRC regulations and guides and industry codes, standards and practices discussed above provide evidence that the nuclear station EDGs are extensively regulated. Aging phenomena are expressly brought into the regulatory framework via 10 CFR 50.49, "Environmental Qualifications of Electric Equipment Important to Safety for Nuclear Power Plants," and ASME Section III and XI. However, the implementation of these regulations has not yet been reviewed.

Surveillance testing and maintenance actions required by the NRC are intended to predict and prevent aging phenomena to the maximum extent practical. However, these tests and actions also have not yet been fully evaluated by the PNL NPAR team. The data presented in Chapter 3.0 suggest that utility implementation is not yet fully effective.

An NRC-industry meeting held in Bethesda, Maryland, on April 30, 1985 ("Meeting to Discuss Diesel-Generator Reliability Issues"), was instructive on several issues pertaining to codes, standards, and regulations. It was suggested that retrofitting code requirements on established, proven engine designs has caused some decrease in reliability. The source of difficulty cited is interfacing between code-required components and pre-existing diesel engine components; coolers and filters are an example. In addition, code requirements for testing, especially pressure testing, have initiated leaks in components interfacing with the tested components. Further, codes have in some instances required the use of equipment without sufficient experience being available to support its application.

NRC regulatory guidance on testing was discussed extensively at the April NRC/industry meeting. There was general agreement that monthly "fast" starts and loading were not necessary to prove engine operability and may in fact be detrimental to long-term reliability. Moreover, the sharply increased frequency of testing with failures that NRC identifies in Regulatory Guide 1.108 (see Table 2.2) was criticized as potentially leading to reduced reliability because of overstressing the engine in start-and-load sequences. EPRI presented two papers at the April 1985 NRC/industry meeting supporting these positions (Wyckoff 1985a, 1985b). No failure data were presented in these papers in support of EPRI's position, but the industry position is clear, based on judgment and experience.

PNL plans to explore these open areas (e.g., aging documentation/conformance), concerns (e.g., testing and code compliance), and industry practices regarding maintenance, surveillance, operations, and condition monitoring in the next part (Phase II) of this study. Each of these research areas will focus on aging concerns for operability and ways to monitor and mitigate these effects. The program will follow the NPAR Phase II plan to achieve the NPAR goals.

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

The evaluation of operating experience and expert opinion has identified diesel-generator systems and components susceptible to aging degradation mechanisms. Classification of failure causes with the associated systems and components provides an analytic tool that can be used to indicate aging problems or identify performance trends. Additionally, a review of current industry regulatory practices has been performed to integrate the diverse and complex standards with preliminary recommendations for operation and maintenance.

The recommendations of this section are derived from the development of the component/recommended corrective-action matrices (see Appendix C). Each failure, evaluated for aging by the PNL NPAR staff, was assigned a primary and a secondary recommended corrective action to return the diesel generator to safe operation (see Table 3.4). Thus, generalizations about the types of corrective actions needed were developed in a manner consistent with the failure cause profile.

## 6.1 CONCLUSIONS

The evaluations performed in this study suggest that aging in diesel-generator systems is observable, changes with time, and is confined to a few major components. More detailed data are needed to definitively investigate the complex failure mechanisms and long-term failure trends in the components identified as subject to aging degradation. However, general trends were revealed that provide realistic insights. These insights will direct the course of future, in-depth examinations of aging mechanisms, focusing on components that are most prone to aging and that affect system safety and operational readiness.

### 6.1.1 Integration of Operating Experience and Expert Opinion

Some differences emerge between expert opinion and operational data analysis. Apparently, the failures witnessed through years of non-nuclear experience are similar to failures occurring in the nuclear industry. Differences in diesel-generator system operation at nuclear facilities do not seem to influence the types of failures, but do appear to affect their rates.

### 6.1.2 Components Subject to Aging

By combining the results of operating experience and expert opinion, the following systems and components were identified as most susceptible to aging degradation:

- instrumentation and controls
    - governor
    - overspeed trip system

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- fuel system
  - injection pumps
  - piping on engine

- starting system
  - controls
  - starting motors
  - starting air valves

- lubrication system
  - pumps

- cooling system
  - pump
  - heat exchangers

- intake and exhaust
  - turbocharger.

Systems moderately subject to aging degradation are:

- instrumentation and controls
  - control air system

- fuel system
  - injectors and nozzles

- lubrication system
  - heat exchangers

- cooling system
  - piping

- engine structure
  - crankcase

- valve mechanisms
  - intake and exhaust valves

- generator

- switchgear
  - relays

- electrical system
  - terminations.

### 6.1.3 Aging Stressors

The primary causes of diesel-generator system aging are, in descending order of significance:

- vibration
  - inherent sensitivity to normal operational vibration
  - sensitivity caused by startup cycles
  - sensitivity caused by poorly manufactured components
  - sensitivity caused by poor installation or maintenance practices

- inferior quality of component
  - poor quality control during manufacturing
  - poor quality control during assembly
  - poor design
  - poor application

- adverse environment
  - inherent sensitivity to normal operational environment
  - unanticipated adverse conditions
  - design deficiencies
  - installation errors

- human error(a)
  - lack of adequate training
  - lack of quality control
  - need for personnel assigned chiefly to diesel generator operation and maintenance if practical.

A review of the primary and secondary failure modes and the comments associated with each major problematic component reveals that the governor was the component most susceptible to aging degradation. An examination of the stressors affecting this component suggests a logical conclusion: the more stressors a component is susceptible to, the greater the chance of failure.

Detailed failure causes for the governor are listed below. This list is only a partial representation of the range of failures. Obviously, the governor system must be examined to identify solutions for the 12 of every 100 aging failures associated with this complex subsystem. Failure causes include:

- poor manufacturing
- defective parts
- parts sensitive to vibration
- parts sensitive to heat
- air in control line
- dirt in mechanisms
- mechanisms out of specification
- drive cables worn
- out of adjustment
- oil deposits on potentiometer motor
- lack of lubrication
- poor maintenance practices
- speed droop knobs vibrated to lower setting
- solenoid failures
- shutdown solenoids vibrated loose
- potentiometers out of adjustment
  - dirt in diode failures
- sheared governor gear pins
  - resistor failures
- freezing weather
- dirty oil
- loose wires
- broken limit switches

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(a) Although human factors can contribute to aging, such stressors are considered outside the scope of this study.

- excessive drift
- poor solder joints
- jammed gears
- trips due to vibration
- excessive component wear
- vibration loosening: screws, terminations, etc.
- improper installation
- defective float valves.

An example of a component moderately subject to aging degradation is the control air system within the instrumentation and controls system. Below is a representative listing of failures:

- loose fittings due to vibration
- regulator bonnet leakage
- failed copper lines
- leaks due to the rubbing together of air lines (due in turn to vibration)
- sticking of 4-way solenoid valve plungers due to dirt and rust
- remounting of regulators (too sensitive to vibration)
- rupture of air regulator diaphragms
- dirt in air
- moisture in air
- failure of air start regulator seals.

Within the instrumentation and controls system, engine shutdown systems were prone to failure by vibration, dirt, stuck valves, defective components, etc. Generally, the range of failures experienced was similar to that experienced by the governor and its systems. Similarly, instrument and control system sensors experienced problems related to vibration and maintenance. The parts were easily damaged and tended toward sudden, unexplained failures.

The fuel system was second to the instrumentation and controls system in failure rate. Overall, 13 of every 100 aging related failures can be attributed to the fuel system. The highest failure rate for a component within the fuel system was 5 failures per 100 aging failures for engine piping (caused primarily by vibration fatigue and loosening). Failure rates for engine piping decreased with time, but only because of a large reduction in manufacturing-related deficiencies (due to "burn-in"). Otherwise, vibration-related failures increased with time. Injector pumps seem to be susceptible to a range of failures, with stuck or loose components predominating the failure histories. The main causes were a combination of vibration and dirt that led to excessive wear.

The starting air system experienced an overall failure rate of 10 per 100 aging failures. The majority of the aging related failures were of controls and starting motors. Most of these failures were due to dirt, debris, and corrosion products entering the system and fouling the operation of key components, orifices, etc. Additionally, defective components, such as the air start relays, check valves, and cracked fittings, added to the failure causes.

Within the lubrication system the pump was the component most inclined to age. Failed bearings, shafts, motor shorts, and clogged filters seemed to predominate the failure reasons. A general improvement in attention to maintenance may reduce such failures.

Pumps failed in the cooling system, primarily due to seals that rapidly deteriorated, worn bearings, and shorted motors. Heat exchangers in the cooling system failed due to tube leaks, biological fouling, erosion, cracked heads, and heater failures. The main causes of failure seemed to be poor choice of heat exchanger type at original design and poor maintenance of the component after installation.

Turbocharger failures were due mainly to vibration, which caused failures of bearings and the speed sensing circuits. Problems of inadequate lubrication, oil leaks, and turbo-housing fatigue cracks were common. Many problems were due to design defects of the accessory lube oil system, which caused turbocharger bearing failures. Incorrect operation and maintenance added to the failures, with incidents such as a closed cooling water valve, causing the entire system to fail. Additionally, cracked welds were common on subcomponents such as the intercooler adapter.

## 6.2 PRELIMINARY RECOMMENDATIONS

As a result of this interim assessment of aging degradation from operating experience and expert opinion, we are proposing the following preliminary recommendations for the operation and maintenance of diesel-generator systems.

- Conduct an active trend analysis program.
    - Identify potentially problematic components early in component life.
    - Employ the latest methods for on-line system monitoring and diagnostics.
    - Perform trend analysis for a comparison of results.
    - Compare performance histories with similar installations, nuclear and non-nuclear.
- Improve maintenance programs.
    - Promote vendor/utility technical training.
    - Dedicate personnel to the diesel-generator systems, fulltime if necessary and practical.
    - Combine the roles of diesel operator and mechanic/electrician.
    - Maintain a basis for and a record of "success analysis" as well as failure analysis for similar systems and components. It is as important to know why another facility is doing well as it is to know what they are doing wrong.

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  - Provide comprehensive maintenance training on fundamental topics such as techniques to combat vibration loosening, etc.
  - Develop a preventive and a predictive maintenance program that aggressively pursues optimal reliability and availability. Fight the "run-it-until-it-breaks" syndrome.
- Develop an aggressive design review/change program.
  - Quickly identify problematic systems and components for design changes.
  - Make design changes as they are identified.
  - Review the design changes implemented throughout the industry for potential problems, and act on them before the problems occur.
- Increase vendor/contractor communications with responsible utility personnel.
  - Conduct and participate in industry workshops and seminars.
  - Ensure that the technical information (i.e., controlled technical manuals) is correct and maintained for the installed units.

## 6.3 FUTURE WORK

Future diesel-generator aging research will be conducted by PNL as a continuation of the established NPAR program strategy. Under this strategy the literature and expert opinion that are the subject of this report will next be supplemented with data and information that reflect current operating practices.

Selected diesel generator systems and components, operating practices, and environments will be investigated for their role in aging degradation under the Phase II assessment using failed component examinations, special laboratory tests, analyses and post-service examinations. Emphasis will be on developing clear performance/diagnostic indicators that will provide timely information well in advance of degraded performance or failure under accident conditions. Other expected project results will be recommendations for improvements in operation and maintenance, materials, practices, designs, and codes and standards that are found to adversely affect long term reliability. Guidelines for service life predictions that relate to plant life extension consideration will be developed.

This NPAR project, which focuses on the aging of diesel generator systems and components, will be coordinated with other relevant NRC diesel generator related and industry programs (see Section 1.2). Although these other programs may not directly address aging, it is anticipated that they will provide additional insights into aging mechanisms and mitigating techniques.

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# APPENDIX A

# THE EMERGENCY DIESEL GENERATOR AGING DATABASE

## APPENDIX A

## THE EMERGENCY DIESEL GENERATOR AGING DATABASE

The EDGAD (Emergency Diesel Generator Aging Data) database was implemented on an IBM-PC using the dBase III (1) relational database management system (dBase). Using the dBase III programming language, programs were developed to facilitate data entry and to generate specific reports used in this analysis. This appendix briefly describes the dBase III software package and discusses the elements of the EDGAD database.

### dBase III

The dBase III relational database management system is a software package designed to allow users to manage and manipulate moderately large amounts of related data using an IBM-PC microcomputer. The system is an upgrade of the dBase II software package and features flexible data definitions (with five defined data types), large database capacity (up to 1 billion records in a database), a built-in application and development programming language, multiple database handling capabilities, and an interactive mode for modifying or interrogating the database.

Index files may be created for any field in the database to allow rapid searches of the data in the indexed field and to conveniently alter the logical ordering of the data. Also, special functions such as AVERAGE, COUNT, and SUM generate data based on the entire database.

The programming language in dBase is similar to other structured programming languages such as BASIC, FORTRAN, and Pascal (it is an interpreted language, like BASIC) but is specifically designed to work with record/field data structures. A simple and somewhat limited word processor is included for developing dBase programs. The programs are in standard ASCII; therefore alternate word processors may be used to develop programs.

dBase also allows conditional modification of data, creation of databases from data external to dBase, easy modification of the record structure of existing databases, and numerous interactive commands for interrogating the database.

### The EDGAD Database

The EDGAD database was created to accommodate the failure data survey described in the body of this report. The fields of the EDGAD database are listed in Table A.1, along with field type and length. Character fields may contain any alpha-numeric data; numeric fields contain real numbers and logical

TABLE A.1. Fields in the EDGAD dBase III Database

| Field Name | Data Type | Length |
|---|---|---|
| Sequence | Character | 5 |
| System | Character | 3 |
| PFailure | Character | 2 |
| SFailure | Character | 2 |
| PAction | Character | 1 |
| SAction | Character | 1 |
| Aging | Logical | 1 |
| Wear | Logical | 1 |
| Nuclear | Logical | 1 |
| Reference | Character | 5 |
| MoYr | Character | 4 |
| Plant | Character | 15 |
| Manf | Character | 5 |
| Model | Character | 10 |
| Age | Numeric | 2 |
| AgeAtEvent | Numeric | 2 |
| Governor | Character | 15 |
| Rating | Character | 6 |
| Turbo | Character | 10 |
| Comments | Character | 254 |
| ***Total Record Length | | 346 |

fields may only assume values of true (.T) or false (.F). The fields listed in Table A.1 correspond to the fields in the input data described in Section 3.2, with the following exceptions:

1. The System field incorporates both the System and Component entries of the input form.
2. The AgeAtEvent field is the approximate age of the plant when the failure event occurred, calculated as:

$$\text{AgeAtEvent} = \text{Age} - (1985 - \text{date of event})$$

where
date of event is recorded in field MoYr.

## The EDGAD dBase Programs

A program to facilitate data entry and to generate specific reports was developed for the EDGAD database. The elements of this program are listed in Table A.2. This program, designed specifically for this project, has undergone regular changes as project needs dictated.

Interactive interrogation of the database using built-in dBase commands was also employed in this study.

TABLE A.2. Elements of the EDGAD dBase III computer Program

| Program Element | Description |
|---|---|
| DEFAD.DBF | Database of diesel engine failure data |
| DGCOMP.DBF | Database with list of engine components included in this study. |
| MAINE.PRG | Main program, which generates selection menu and calls the various procedures. |
| DGENTRY.PRG | Program to facilitate data entry and provide first-level data validation. |
| DGREDEX.PRG | Program to remove records marked for deletion and update index files. |
| COUNTER.PRG | Program to count the number of entries in the database with specific, user-selected attributes. This procedure provides a menu of report options and includes calls to TALLYSEL.PRG, TALLYPF.PRG, and TALLYPA.PRG. |
| TALLYSEL.PRG | Program that allows the user to select the attributes of the records to be included in a report. For example, a report counting failure data may be set to count only data at nuclear installations. |
| TALLYPF.PRG | Program that counts the number of failures in each primary failure category given a specific component. |
| TALLYPA.PRG | Program that counts the number of actions in each primary corrective action category given a specific component. |
| DRIVER.PRG | Program to batch operation of the report generator. |
| SYSPA.NDX | Index file used in TALLYPA.PRG. |
| SYSPF.NDX | Index file used in TALLYPF.PRG. |

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# APPENDIX B

## THE COMPONENT/FAILURE CAUSE MATRICES

## TABLE B.1. Summary of Diesel Engine Failure Data, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - CRANKCASE | 4 | 1 | 0 | 9 | 5 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 1 | 0 | 29 | |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEADS | 2 | 7 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 17 | |
| - MAIN BEARINGS | 3 | 3 | 0 | 1 | 3 | 1 | 2 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 19 | |
| - LINERS | 4 | 6 | 1 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 5 | 0 | 22 | |
| - OTHER | 2 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| | | | | | | | | | | | | | | | | 100 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 7 | |
| - CONN RODS | 3 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 | |
| - PISTONS | 4 | 8 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 19 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 5 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | |
| - OTHER | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 51 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - ROCKER ARM ASSEMBLY | 1 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - INTAKE & EXHAUST VALVE | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 5 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | |
| | | | | | | | | | | | | | | | | 18 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - STARTING AIR VALVE | 2 | 10 | 0 | 4 | 18 | 1 | 0 | 0 | 0 | 8 | 0 | 0 | 3 | 0 | 46 | |
| - AIR COMPRESSOR | 1 | 7 | 1 | 3 | 4 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 21 | |
| - CONTROLS | 2 | 7 | 0 | 3 | 13 | 0 | 5 | 0 | 2 | 7 | 0 | 0 | 14 | 2 | 55 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | |
| - TANKS | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | |
| - STARTING MOTORS | 4 | 7 | 0 | 3 | 14 | 0 | 3 | 0 | 0 | 8 | 0 | 0 | 7 | 0 | 46 | |
| - OTHER | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 7 | 0 | 16 | |
| | | | | | | | | | | | | | | | | 197 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - TURBOCHARGER | 13 | 30 | 0 | 11 | 3 | 3 | 3 | 0 | 2 | 4 | 1 | 0 | 7 | 2 | 79 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 3 | 4 | 1 | 11 | 4 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 29 | |
| | | | | | | | | | | | | | | | | 113 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 11 | 1 | 10 | 10 | 1 | 1 | 0 | 2 | 6 | 0 | 0 | 3 | 0 | 45 | |
| - STRAINERS & FILTERS | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 11 | |
| - FUEL OIL PUMPS | 1 | 2 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 6 | 1 | 0 | 2 | 0 | 18 | |
| - OIL STORAGE | 0 | 1 | 0 | 1 | 4 | 0 | 3 | 0 | 3 | 1 | 0 | 0 | 3 | 2 | 18 | |
| - PIPING ON ENGINE | 0 | 14 | 1 | 35 | 3 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 3 | 0 | 61 | |
| - INJECTORS & NOZZLES | 0 | 2 | 0 | 9 | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 21 | |
| - FUEL | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - OTHERS | 1 | 9 | 0 | 4 | 6 | 1 | 3 | 0 | 2 | 9 | 0 | 0 | 1 | 0 | 36 | |
| | | | | | | | | | | | | | | | | 215 |

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## TABLE B.1. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 9 | 0 | 6 | 6 | 0 | 4 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 27 |
| - FILTERS | 0 | 4 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 7 | 0 | 0 | 2 | 0 | 16 |
| - STRAINERS | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 9 |
| - HEAT EXCHANGERS | 2 | 9 | 0 | 3 | 5 | 1 | 0 | 1 | 0 | 4 | 0 | 0 | 3 | 0 | 28 |
| - CONTROL VALVES | 1 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - PIPING | 2 | 2 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 9 | 1 | 1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 19 |
| - OTHER | 1 | 1 | 1 | 2 | 0 | 1 | 2 | 0 | 2 | 1 | 0 | 0 | 3 | 0 | 14 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 3 | 8 | 1 | 11 | 6 | 1 | 4 | 1 | 1 | 5 | 0 | 0 | 2 | 0 | 43 |
| - HEAT EXCHANGERS | 4 | 12 | 1 | 5 | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 32 |
| - INTERCOOLER | 0 | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - RADIATOR | 2 | 2 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 12 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 7 | 2 | 10 | 2 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 4 | 1 | 33 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 |
| - OTHER | 5 | 10 | 1 | 2 | 3 | 1 | 2 | 0 | 2 | 8 | 0 | 0 | 5 | 0 | 39 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 4 | 7 | 1 | 4 | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 27 |
| - EXCITER | 0 | 2 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 3 | 0 | 14 |
| - VOLTAGE REGULATOR | 1 | 10 | 0 | 3 | 4 | 0 | 4 | 0 | 2 | 4 | 0 | 0 | 8 | 0 | 36 |
| - PEDESTAL BEARINGS | 1 | 1 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| - OTHER | 4 | 7 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 21 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 3 | 15 | 0 | 3 | 9 | 1 | 12 | 1 | 3 | 8 | 1 | 1 | 5 | 2 | 64 |
| - RELAYS | 11 | 28 | 2 | 4 | 14 | 3 | 12 | 0 | 1 | 8 | 0 | 0 | 3 | 4 | 90 |
| - INSTRUMENT & CNTRL | 2 | 6 | 0 | 3 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 4 | 3 | 22 |
| - OTHER | 1 | 6 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 3 | 0 | 18 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 7 | 43 | 1 | 24 | 17 | 2 | 17 | 0 | 3 | 30 | 0 | 0 | 19 | 0 | 163 |
| - OVERSPEED GOVERNOR | 1 | 6 | 0 | 6 | 3 | 1 | 11 | 0 | 3 | 5 | 0 | 0 | 3 | 0 | 39 |
| - CONTROL VALVES | 0 | 1 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 9 |
| - ALARMS AND SHUTDOWNS | 0 | 4 | 0 | 18 | 2 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 34 |
| - LINKAGES | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 3 | 0 | 17 |
| - STARTUP SYSTEM | 4 | 3 | 0 | 2 | 4 | 1 | 4 | 0 | 3 | 6 | 0 | 1 | 14 | 2 | 44 |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 18 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 29 |
| - WIRING & TERMINATIONS | 0 | 3 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 19 |
| - RELAYS | 4 | 5 | 0 | 7 | 6 | 1 | 7 | 1 | 0 | 2 | 0 | 0 | 13 | 2 | 48 |
| - SENSORS | 4 | 21 | 0 | 11 | 3 | 2 | 8 | 1 | 0 | 10 | 0 | 0 | 8 | 1 | 69 |
| - OTHER | 1 | 5 | 0 | 6 | 1 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 10 | 0 | 27 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 3 |

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TABLE B.1. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - PIPING SUPPORTS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 6 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 12 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 9 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | |
| - WIRING, CONDUIT, ETC | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 9 | |
| - TRANSFORMERS | 1 | 4 | 0 | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | |
| - CONTROLS | 0 | 9 | 0 | 2 | 1 | 3 | 1 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 22 | |
| - OTHER | 7 | 17 | 0 | 2 | 3 | 2 | 7 | 0 | 0 | 17 | 1 | 0 | 0 | 2 | 58 | 112 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 4 | 1 | 3 | 1 | 0 | 4 | 0 | 2 | 8 | 0 | 3 | 4 | 0 | 31 | 31 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 9 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 5 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 7 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 144 | 440 | 22 | 331 | 252 | 51 | 153 | 6 | 69 | 262 | 8 | 5 | 209 | 32 | 1984 | |

**TABLE B.2.** Summary of Diesel Engine Failure Data, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - CRANKCASE | 1 | 1 | 0 | 9 | 5 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 1 | 0 | 26 | |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEADS | 2 | 3 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 10 | |
| - MAIN BEARINGS | 3 | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 12 | |
| - LINERS | 4 | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 16 | |
| - OTHER | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 71 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 6 | |
| - CONN RODS | 2 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | |
| - PISTONS | 3 | 5 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 13 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 36 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - ROCKER ARM ASSEMBLY | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 14 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 2 | 6 | 0 | 4 | 16 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 3 | 0 | 36 | |
| - AIR COMPRESSOR | 0 | 1 | 1 | 3 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 10 | |
| - CONTROLS | 2 | 2 | 0 | 3 | 11 | 0 | 2 | 0 | 1 | 4 | 0 | 0 | 5 | 1 | 31 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - STARTING MOTORS | 0 | 2 | 0 | 2 | 11 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 22 | |
| - OTHER | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 9 | |
| | | | | | | | | | | | | | | | | 110 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 7 | 16 | 0 | 6 | 3 | 1 | 2 | 0 | 0 | 2 | 0 | 0 | 6 | 0 | 45 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 1 | 1 | 0 | 11 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 17 | |
| | | | | | | | | | | | | | | | | 65 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 8 | 1 | 10 | 8 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 3 | 0 | 34 | |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 7 | |
| - FUEL OIL PUMPS | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 2 | 0 | 10 | |
| - OIL STORAGE | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 7 | |
| - PIPING ON ENGINE | 0 | 11 | 1 | 34 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 52 | |
| - INJECTORS & NOZZLES | 0 | 2 | 0 | 9 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 20 | |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHERS | 0 | 2 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 10 | |
| | | | | | | | | | | | | | | | | 141 |

# TABLE B.2. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 3 | 0 | 6 | 6 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 18 |
| - FILTERS | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 9 |
| - STRAINERS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| - HEAT EXCHANGERS | 1 | 4 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 18 |
| - CONTROL VALVES | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - PIPING | 1 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 8 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 12 |
| - OTHER | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 6 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 2 | 1 | 10 | 4 | 1 | 3 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 26 |
| - HEAT EXCHANGERS | 1 | 7 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 20 |
| - INTERCOOLER | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - RADIATOR | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 7 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 4 | 2 | 10 | 2 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 2 | 0 | 25 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 3 | 3 | 1 | 2 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 19 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 4 | 1 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 16 |
| - EXCITER | 0 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 10 |
| - VOLTAGE REGULATOR | 0 | 5 | 0 | 1 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 17 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 3 | 0 | 2 | 1 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 16 |
| - RELAYS | 0 | 5 | 1 | 1 | 6 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 16 |
| - INSTRUMENT & CNTRL | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 7 |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 7 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 3 | 31 | 0 | 22 | 13 | 0 | 10 | 0 | 2 | 14 | 0 | 0 | 14 | 0 | 109 |
| - OVERSPEED GOVERNOR | 0 | 2 | 0 | 5 | 3 | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 2 | 0 | 20 |
| - CONTROL VALVES | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 18 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 23 |
| - LINKAGES | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 2 | 0 | 15 |
| - STARTUP SYSTEM | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 10 |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 17 | 3 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 26 |
| - WIRING & TERMINATIONS | 0 | 3 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 19 |
| - RELAYS | 1 | 2 | 0 | 6 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 26 |
| - SENSORS | 1 | 6 | 0 | 7 | 3 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 7 | 0 | 29 |
| - OTHER | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 14 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

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## TABLE B.2. (contd)

| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | |
| - TRANSFORMERS | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - CONTROLS | 0 | 4 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 11 | |
| - OTHER | 0 | 6 | 0 | 1 | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 13 | 32 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 2 | 1 | 2 | 1 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 12 | 12 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 49 | 191 | 16 | 290 | 177 | 10 | 61 | 1 | 19 | 96 | 4 | 0 | 146 | 2 | 1064 | |

## TABLE B.3. Summary of Engine Failure Data, Abnormal Failures

| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ENGINE STRUCTURE** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - BASE | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - CRANKCASE | 2 | 1 | 0 | 7 | 2 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 21 | |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEADS | 2 | 7 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | |
| - MAIN BEARINGS | 3 | 3 | 0 | 1 | 3 | 1 | 2 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 18 | |
| - LINERS | 4 | 6 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 18 | |
| - OTHER | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 82 |
| **DRIVE TRAIN** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 6 | |
| - CONN RODS | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | |
| - PISTONS | 4 | 8 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 17 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | |
| - OTHER | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 44 |
| **VALVE MECHANISMS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - ROCKER ARM ASSEMBLY | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - INTAKE & EXHAUST VALVE | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 |
| **STARTING COMPONENTS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 2 | 10 | 0 | 3 | 16 | 1 | 0 | 0 | 0 | 7 | 0 | 0 | 2 | 0 | 41 | |
| - AIR COMPRESSOR | 1 | 6 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | |
| - CONTROLS | 1 | 6 | 0 | 3 | 7 | 0 | 3 | 0 | 1 | 2 | 0 | 0 | 1 | 1 | 25 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - TANKS | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | |
| - STARTING MOTORS | 4 | 5 | 0 | 3 | 9 | 0 | 3 | 0 | 0 | 6 | 0 | 0 | 1 | 0 | 31 | |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 122 |
| **INTAKE AND EXHAUST** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - TURBOCHARGER | 11 | 27 | 0 | 7 | 1 | 2 | 3 | 0 | 1 | 3 | 1 | 0 | 3 | 1 | 60 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 3 | 4 | 1 | 10 | 3 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 26 | 90 |
| **FUEL COMPONENTS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 11 | 0 | 8 | 10 | 1 | 1 | 0 | 2 | 6 | 0 | 0 | 1 | 0 | 40 | |
| - STRAINERS & FILTERS | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 6 | |
| - FUEL OIL PUMPS | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 7 | |
| - OIL STORAGE | 0 | 1 | 0 | 1 | 1 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 9 | |
| - PIPING ON ENGINE | 0 | 13 | 1 | 26 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 46 | |
| - INJECTORS & NOZZLES | 0 | 2 | 0 | 7 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHERS | 1 | 7 | 0 | 2 | 5 | 1 | 2 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 26 | 149 |

## TABLE B.3. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 9 | 0 | 5 | 4 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 23 | |
| - FILTERS | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 10 | |
| - STRAINERS | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 7 | |
| - HEAT EXCHANGERS | 1 | 9 | 0 | 3 | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 18 | |
| - CONTROL VALVES | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - PIPING | 1 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | |
| - LUBE OIL | 0 | 1 | 0 | 0 | 4 | 1 | 1 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 12 | |
| - OTHER | 1 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 8 | 91 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 3 | 7 | 1 | 5 | 3 | 1 | 4 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 29 | |
| - HEAT EXCHANGERS | 4 | 8 | 1 | 3 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 22 | |
| - INTERCOOLER | 0 | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | |
| - RADIATOR | 2 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 7 | 1 | 9 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 2 | 0 | 25 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 4 | 8 | 0 | 2 | 1 | 1 | 2 | 0 | 1 | 4 | 0 | 0 | 1 | 0 | 24 | 119 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 3 | 5 | 0 | 3 | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 20 | |
| - EXCITER | 0 | 2 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 10 | |
| - VOLTAGE REGULATOR | 1 | 5 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 15 | |
| - PEDESTAL BEARINGS | 1 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - OTHER | 3 | 7 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 19 | 70 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 3 | 12 | 0 | 2 | 7 | 1 | 8 | 1 | 1 | 5 | 1 | 1 | 0 | 1 | 43 | |
| - RELAYS | 11 | 23 | 1 | 3 | 8 | 3 | 10 | 0 | 0 | 8 | 0 | 0 | 0 | 3 | 70 | |
| - INSTRUMENT & CNTRL | 0 | 6 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 11 | |
| - OTHER | 0 | 5 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 11 | 135 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 4 | 37 | 1 | 14 | 12 | 2 | 5 | 0 | 2 | 22 | 0 | 0 | 1 | 0 | 100 | |
| - OVERSPEED GOVERNOR | 1 | 4 | 0 | 5 | 3 | 1 | 9 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 30 | |
| - CONTROL VALVES | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 7 | |
| - ALARMS AND SHUTDOWNS | 0 | 4 | 0 | 11 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | |
| - LINKAGES | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 9 | |
| - STARTUP SYSTEM | 1 | 3 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 15 | |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 13 | 4 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 20 | |
| - WIRING & TERMINATIONS | 0 | 3 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 14 | |
| - RELAYS | 2 | 5 | 0 | 5 | 5 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 26 | |
| - SENSORS | 3 | 17 | 0 | 7 | 2 | 2 | 4 | 1 | 0 | 8 | 0 | 0 | 2 | 1 | 47 | |
| - OTHER | 1 | 5 | 0 | 3 | 0 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 15 | 302 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

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## TABLE B.3. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING SUPPORTS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 4 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 9 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | |
| - WIRING,CONDUIT,ETC | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 | |
| - TRANSFORMERS | 0 | 4 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | |
| - CONTROLS | 0 | 8 | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 16 | |
| - OTHER | 6 | 11 | 0 | 1 | 1 | 2 | 5 | 0 | 0 | 16 | 1 | 0 | 0 | 2 | 45 | 86 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 3 | 1 | 2 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 14 | 14 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 115 | 384 | 15 | 237 | 157 | 46 | 106 | 6 | 33 | 172 | 6 | 2 | 35 | 22 | 1336 | |

TABLE B.4. Summary of Diesel Engine Failure Data, Abnormal Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CRANKCASE | 1 | 1 | 0 | 7 | 2 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 20 |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 2 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| - MAIN BEARINGS | 3 | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 11 |
| - LINERS | 4 | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 13 |
| - OTHER | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 |
| - CONN RODS | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 |
| - PISTONS | 3 | 5 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ROCKER ARM ASSEMBLY | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 2 | 6 | 0 | 3 | 14 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 31 |
| - AIR COMPRESSOR | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - CONTROLS | 1 | 2 | 0 | 3 | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - STARTING MOTORS | 0 | 0 | 0 | 2 | 6 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 10 |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 7 | 17 | 0 | 3 | 1 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 35 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 1 | 1 | 0 | 10 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 15 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 8 | 0 | 8 | 8 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 29 |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| - OIL STORAGE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - PIPING ON ENGINE | 0 | 11 | 1 | 25 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 42 |
| - INJECTORS & NOZZLES | 0 | 2 | 0 | 7 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

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## TABLE B.4. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 3 | 0 | 5 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | |
| - FILTERS | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - STRAINERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - HEAT EXCHANGERS | 1 | 4 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | |
| - CONTROL VALVES | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - PIPING | 1 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | |
| - LUBE OIL | 0 | 1 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 48 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 1 | 4 | 1 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 12 | |
| - HEAT EXCHANGERS | 1 | 4 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 | |
| - INTERCOOLER | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - RADIATOR | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 4 | 1 | 9 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 0 | 20 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 2 | 1 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 9 | 61 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 2 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 10 | |
| - EXCITER | 0 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 7 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 22 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 2 | 25 | 0 | 13 | 8 | 0 | 0 | 0 | 2 | 13 | 0 | 0 | 1 | 0 | 64 | |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 4 | 3 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 13 | |
| - CONTROL VALVES | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | |
| - LINKAGES | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 9 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 13 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 19 | |
| - WIRING & TERMINATIONS | 0 | 3 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 14 | |
| - RELAYS | 0 | 2 | 0 | 5 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | |
| - SENSORS | 0 | 4 | 0 | 5 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 14 | |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 165 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

## TABLE B.4. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| - TRANSFORMERS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROLS | 0 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |

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| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 2 | 1 | 1 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 10 |

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| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 41 | 146 | 9 | 204 | 95 | 7 | 23 | 1 | 16 | 55 | 3 | 0 | 26 | 1 | 629 |

TABLE B.5. Summary of Diesel Engine Failure Data, AGEATEVENT = 0,[(a)] All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CRANKCASE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 |
| - OTHER | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 3 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - ROCKER ARM ASSEMBLY | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INTAKE & EXHAUST VALVE | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 2 | 2 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 13 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROLS | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 9 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTING MOTORS | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 7 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 1 | 6 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - FUEL OIL PUMPS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| - PIPING ON ENGINE | 0 | 5 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 12 |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 7 |

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(a) AGEATEVENT, i.e., age at event.

## TABLE B.5. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - HEAT EXCHANGERS | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - HEAT EXCHANGERS | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - INTERCOOLER | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 4 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 2 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 8 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - EXCITER | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - VOLTAGE REGULATOR | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 1 | 3 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 10 |
| - RELAYS | 6 | 7 | 0 | 0 | 2 | 3 | 4 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 27 |
| - INSTRUMENT & CONTROL | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 3 | 15 | 0 | 0 | 2 | 1 | 1 | 0 | 1 | 5 | 0 | 0 | 1 | 0 | 29 |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 6 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - RELAYS | 1 | 1 | 0 | 3 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 11 |
| - SENSORS | 2 | 5 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 15 |
| - OTHER | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.5. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - WIRING, CONDUIT, ETC | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - TRANSFORMERS | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 1 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 12 | |
| | | | | | | | | | | | | | | | | 24 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 6 | |
| | | | | | | | | | | | | | | | | 6 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 43 | 107 | 3 | 37 | 37 | 17 | 27 | 1 | 12 | 35 | 2 | 1 | 29 | 3 | 354 | |

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TABLE B.6. Summary of Diesel Engine Failure Data, AGEATEVENT >1, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - CRANKCASE | 3 | 1 | 0 | 8 | 4 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 22 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 6 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 13 | |
| - MAIN BEARINGS | 2 | 2 | 0 | 0 | 3 | 1 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 14 | |
| - LINERS | 4 | 4 | 1 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 18 | |
| - OTHER | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 74 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONN RODS | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | |
| - PISTONS | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 21 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - ROCKER ARM ASSEMBLY | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | |
| | | | | | | | | | | | | | | | | 12 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - STARTING AIR VALVE | 0 | 6 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 1 | 0 | 22 | |
| - AIR COMPRESSOR | 1 | 6 | 1 | 3 | 3 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 18 | |
| - CONTROLS | 0 | 6 | 0 | 3 | 9 | 0 | 1 | 0 | 1 | 6 | 0 | 0 | 11 | 2 | 39 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - STARTING MOTORS | 2 | 7 | 0 | 3 | 11 | 0 | 3 | 0 | 0 | 4 | 0 | 0 | 7 | 0 | 37 | |
| - OTHER | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 9 | |
| | | | | | | | | | | | | | | | | 134 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - TURBOCHARGER | 12 | 22 | 0 | 7 | 3 | 2 | 1 | 0 | 2 | 4 | 1 | 0 | 6 | 2 | 62 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 3 | 4 | 1 | 10 | 3 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 26 | |
| | | | | | | | | | | | | | | | | 92 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 7 | 1 | 10 | 8 | 1 | 0 | 0 | 2 | 5 | 0 | 0 | 3 | 0 | 37 | |
| - STRAINERS & FILTERS | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 9 | |
| - FUEL OIL PUMPS | 0 | 1 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 6 | 1 | 0 | 2 | 0 | 15 | |
| - OIL STORAGE | 0 | 1 | 0 | 1 | 1 | 0 | 3 | 0 | 2 | 1 | 0 | 0 | 2 | 2 | 13 | |
| - PIPING ON ENGINE | 0 | 6 | 1 | 29 | 2 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 43 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 5 | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 14 | |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHERS | 1 | 9 | 0 | 2 | 5 | 0 | 2 | 0 | 1 | 6 | 0 | 0 | 1 | 0 | 27 | |
| | | | | | | | | | | | | | | | | 160 |

## TABLE B.6. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 8 | 0 | 5 | 6 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 23 |
| - FILTERS | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 2 | 0 | 10 |
| - STRAINERS | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 6 |
| - HEAT EXCHANGERS | 2 | 8 | 0 | 1 | 4 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 2 | 0 | 21 |
| - CONTROL VALVES | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - PIPING | 2 | 2 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 12 |
| - OTHER | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 11 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 2 | 7 | 1 | 10 | 4 | 0 | 4 | 1 | 1 | 5 | 0 | 0 | 2 | 0 | 37 |
| - HEAT EXCHANGERS | 3 | 10 | 1 | 3 | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 26 |
| - INTERCOOLER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RADIATOR | 2 | 2 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 11 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 6 | 2 | 8 | 2 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 3 | 0 | 26 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| - OTHER | 3 | 5 | 1 | 1 | 2 | 1 | 2 | 0 | 0 | 8 | 0 | 0 | 5 | 0 | 28 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 2 | 3 | 1 | 2 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 17 |
| - EXCITER | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 8 |
| - VOLTAGE REGULATOR | 0 | 8 | 0 | 3 | 3 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 6 | 0 | 27 |
| - PEDESTAL BEARINGS | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - OTHER | 4 | 7 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 18 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 2 | 10 | 0 | 2 | 8 | 1 | 10 | 1 | 3 | 7 | 0 | 0 | 5 | 2 | 51 |
| - RELAYS | 3 | 17 | 1 | 4 | 11 | 0 | 8 | 0 | 0 | 6 | 0 | 0 | 1 | 2 | 53 |
| - INSTRUMENT & CNTRL | 2 | 3 | 0 | 3 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 15 |
| - OTHER | 1 | 5 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 11 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 3 | 26 | 1 | 23 | 8 | 1 | 14 | 0 | 2 | 22 | 0 | 0 | 16 | 0 | 116 |
| - OVERSPEED GOVERNOR | 1 | 5 | 0 | 4 | 3 | 1 | 11 | 0 | 1 | 5 | 0 | 0 | 3 | 0 | 34 |
| - CONTROL VALVES | 0 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 |
| - ALARMS AND SHUTDOWNS | 0 | 2 | 0 | 15 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 28 |
| - LINKAGES | 0 | 0 | 0 | 5 | 4 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 3 | 0 | 16 |
| - STARTUP SYSTEM | 2 | 2 | 0 | 2 | 4 | 0 | 4 | 0 | 2 | 5 | 0 | 1 | 12 | 1 | 35 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 15 | 4 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 24 |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 14 |
| - RELAYS | 1 | 2 | 0 | 4 | 3 | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 9 | 1 | 26 |
| - SENSORS | 2 | 14 | 0 | 9 | 1 | 1 | 7 | 1 | 0 | 6 | 0 | 0 | 5 | 1 | 47 |
| - OTHER | 1 | 2 | 0 | 5 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 8 | 0 | 20 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - RAILS, CHOCKS, ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 3 |

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## TABLE B.6. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 5 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 10 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 3 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | |
| - WIRING,CONDUIT,ETC | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 6 | |
| - TRANSFORMERS | 0 | 3 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - CONTROLS | 0 | 7 | 0 | 2 | 1 | 3 | 1 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 20 | |
| - OTHER | 6 | 11 | 0 | 1 | 3 | 1 | 5 | 0 | 0 | 11 | 0 | 0 | 0 | 2 | 40 | 79 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 3 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 7 | 0 | 3 | 1 | 0 | 19 | 19 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 5 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 5 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 5 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 86 | 293 | 17 | 267 | 178 | 29 | 110 | 5 | 49 | 202 | 5 | 4 | 161 | 24 | 1430 | |

TABLE B.7. Summary of Diesel Engine Failure Data, AGEATEVENT >5, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CRANKCASE | 1 | 0 | 0 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - MAIN BEARINGS | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 | |
| - LINERS | 2 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 | |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 33 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PISTONS | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 11 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - ROCKER ARM ASSEMBLY | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | |
| | | | | | | | | | | | | | | | | 12 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - STARTING AIR VALVE | 0 | 4 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 14 | |
| - AIR COMPRESSOR | 0 | 5 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 11 | |
| - CONTROLS | 0 | 1 | 0 | 3 | 7 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | 2 | 25 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 1 | 2 | 0 | 2 | 8 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 23 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 82 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 7 | 9 | 0 | 5 | 0 | 2 | 1 | 0 | 2 | 3 | 0 | 0 | 5 | 1 | 35 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 2 | 2 | 0 | 4 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 12 | |
| | | | | | | | | | | | | | | | | 47 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 3 | 0 | 7 | 7 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 22 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 4 | 1 | 0 | 2 | 0 | 11 | |
| - OIL STORAGE | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 2 | 0 | 10 | |
| - PIPING ON ENGINE | 0 | 4 | 1 | 12 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 19 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 4 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 12 | |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHERS | 1 | 4 | 0 | 2 | 4 | 0 | 2 | 0 | 1 | 4 | 0 | 0 | 1 | 0 | 19 | |
| | | | | | | | | | | | | | | | | 97 |

## TABLE B.7. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 5 | 0 | 5 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| - FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 7 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 7 |
| - CONTROL VALVES | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 2 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 2 | 4 | 1 | 9 | 2 | 0 | 1 | 0 | 1 | 5 | 0 | 0 | 1 | 0 | 26 |
| - HEAT EXCHANGERS | 3 | 8 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 20 |
| - INTERCOOLER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RADIATOR | 2 | 1 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 10 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 3 | 2 | 6 | 2 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 18 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 13 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 2 | 3 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 13 |
| - EXCITER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| - VOLTAGE REGULATOR | 0 | 2 | 0 | 3 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 14 |
| - PEDESTAL BEARINGS | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 8 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 2 | 2 | 0 | 1 | 8 | 1 | 6 | 1 | 2 | 1 | 0 | 0 | 2 | 2 | 28 |
| - RELAYS | 1 | 8 | 0 | 3 | 4 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 22 |
| - INSTRUMENT & CNTRL | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 7 |
| - OTHER | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 5 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 2 | 19 | 1 | 12 | 5 | 1 | 10 | 0 | 1 | 12 | 0 | 0 | 11 | 0 | 74 |
| - OVERSPEED GOVERNOR | 1 | 3 | 0 | 2 | 3 | 0 | 3 | 0 | 1 | 4 | 0 | 0 | 3 | 0 | 20 |
| - CONTROL VALVES | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - ALARMS AND SHUTDOWNS | 0 | 2 | 0 | 7 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 17 |
| - LINKAGES | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 7 |
| - STARTUP SYSTEM | 2 | 0 | 0 | 2 | 2 | 0 | 4 | 0 | 1 | 2 | 0 | 1 | 3 | 0 | 17 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 8 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 14 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 9 |
| - RELAYS | 1 | 1 | 0 | 3 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 15 |
| - SENSORS | 1 | 8 | 0 | 7 | 1 | 0 | 3 | 1 | 0 | 5 | 0 | 0 | 3 | 0 | 29 |
| - OTHER | 0 | 2 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 13 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |

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## TABLE B.7. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 6 |
| **ELECTRICAL SYSTEMS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - WIRING, CONDUIT, ETC | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | |
| - TRANSFORMERS | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - CONTROLS | 0 | 5 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 12 | |
| - OTHER | 5 | 9 | 0 | 1 | 1 | 1 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 28 | 51 |
| **MISCELLANEOUS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **UNRELATED TO EDG** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 10 | 10 |
| **EDG FUNCTIONS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 4 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| **TOTAL** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 56 | 149 | 11 | 163 | 117 | 19 | 66 | 4 | 26 | 108 | 1 | 1 | 89 | 11 | 821 | |

**TABLE B.8.** Summary of Diesel Engine Failure Data, AGEATEVENT = 0, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CRANKCASE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - ROCKER ARM ASSEMBLY | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 2 | 1 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 11 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROLS | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING ON ENGINE | 0 | 5 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 10 |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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## TABLE B.8. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTERCOOLER | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - EXCITER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

9

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

6

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 2 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 15 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - RELAYS | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - SENSORS | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

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## TABLE B.8. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TRANSFORMERS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |

3

| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

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| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 13 | 43 | 2 | 31 | 23 | 3 | 9 | 0 | 3 | 7 | 1 | 0 | 20 | 0 | 155 |

## TABLE B.9. Summary of Diesel Engine Failure Data, AGEATEVENT >5, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CRANKCASE | 0 | 0 | 0 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - MAIN BEARINGS | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - LINERS | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 28 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PISTONS | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 9 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - ROCKER ARM ASSEMBLY | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 9 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 2 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 11 | |
| - AIR COMPRESSOR | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - CONTROLS | 0 | 1 | 0 | 3 | 7 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 1 | 17 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 1 | 0 | 1 | 6 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 13 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 48 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 5 | 7 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 23 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8 | |
| | | | | | | | | | | | | | | | | 31 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 3 | 0 | 7 | 6 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 19 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 2 | 0 | 7 | |
| - OIL STORAGE | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | |
| - PIPING ON ENGINE | 0 | 2 | 1 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 11 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | |
| | | | | | | | | | | | | | | | | 63 |

## TABLE B.9. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 2 | 0 | 5 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| - FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 6 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| - CONTROL VALVES | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 1 | 8 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 15 |
| - HEAT EXCHANGERS | 1 | 6 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 12 |
| - INTERCOOLER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RADIATOR | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 2 | 2 | 6 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 16 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - EXCITER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - VOLTAGE REGULATOR | 0 | 2 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 8 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 2 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 |
| - RELAYS | 0 | 5 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 15 | 0 | 10 | 5 | 0 | 8 | 0 | 1 | 7 | 0 | 0 | 8 | 0 | 54 |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 2 | 3 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 2 | 0 | 11 |
| - CONTROL VALVES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 9 |
| - LINKAGES | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 6 |
| - STARTUP SYSTEM | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 7 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 12 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 9 |
| - RELAYS | 0 | 1 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 9 |
| - SENSORS | 1 | 3 | 0 | 3 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 13 |
| - OTHER | 0 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 9 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.9. (contd)

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - TRANSFORMERS | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - CONTROLS | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | |
| - OTHER | 0 | 5 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 21 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 19 | 84 | 9 | 143 | 87 | 2 | 25 | 1 | 5 | 46 | 1 | 0 | 66 | 1 | 489 | |

TABLE B.10. Summary of Diesel Engine Failure Data, AGEATEVENT <5, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CRANKCASE | 1 | 1 | 0 | 3 | 1 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 15 |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - MAIN BEARINGS | 2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 8 |
| - LINERS | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 9 |
| - OTHER | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| - CONNECTING RODS | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - PISTONS | 2 | 4 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ROCKER ARM ASSEMBLY | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 2 | 4 | 0 | 2 | 11 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 25 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 5 |
| - CONTROLS | 2 | 1 | 0 | 0 | 4 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 14 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - STARTING MOTORS | 0 | 1 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 9 |
| - OTHER | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 8 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 2 | 11 | 0 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 22 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 1 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 9 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 5 | 1 | 3 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 15 |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 6 |
| - FUEL OIL PUMPS | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - PIPING ON ENGINE | 0 | 9 | 0 | 22 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 36 |
| - INJECTORS & NOZZLES | 0 | 2 | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 5 |

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## TABLE B.10. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| - FILTERS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - STRAINERS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - HEAT EXCHANGERS | 0 | 4 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 12 |
| - CONTROL VALVES | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - PIPING | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 7 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 10 |
| - OTHER | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 2 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 |
| - HEAT EXCHANGERS | 0 | 1 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - INTERCOOLER | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 9 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 1 | 3 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 13 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 8 |
| - EXCITER | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 8 |
| - VOLTAGE REGULATOR | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 9 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 9 |
| - RELAYS | 0 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 |
| - INSTRUMENT & CONTROL | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 6 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 3 | 16 | 0 | 12 | 8 | 0 | 2 | 0 | 1 | 7 | 0 | 0 | 6 | 0 | 55 |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 3 | 0 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 9 |
| - CONTROL VALVES | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 14 |
| - LINKAGES | 0 | 0 | 0 | 4 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 9 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 4 |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 14 |
| - WIRING & TERMINATIONS | 0 | 3 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 10 |
| - RELAYS | 1 | 1 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 17 |
| - SENSORS | 0 | 3 | 0 | 4 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 16 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 5 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS, CHOCKS, ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

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## TABLE B.10. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |
| - TRANSFORMERS | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 4 | 11 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 1 | 2 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 9 | 9 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 30 | 107 | 7 | 147 | 90 | 8 | 36 | 0 | 14 | 50 | 3 | 0 | 82 | 1 | 575 | |

TABLE B.11. Summary of Diesel Engine Failure Data, AGEATEVENT = 1, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 6 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - CONNECTING RODS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 2 | 0 | 1 | 6 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

3

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - PIPING ON ENGINE | 0 | 3 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

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## TABLE B.11. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FILTERS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 9 |
| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INTERCOOLER | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 10 |
| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - GENERATOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - EXCITER | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 4 |
| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 5 |
| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - GOVERNOR | 0 | 2 | 0 | 1 | 5 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 11 | |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - RELAYS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | |
| - SENSORS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 26 |
| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

## TABLE B.11. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 2 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 6 | 16 | 2 | 21 | 25 | 1 | 11 | 0 | 4 | 11 | 0 | 0 | 12 | 0 | 109 | |

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## TABLE B.12. Summary of Diesel Engine Failure Data, AGEATEVENT = 2, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| - LINERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONNECTING RODS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PISTONS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 1 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.12. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | 6 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 6 | |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | |
| - RELAYS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

## TABLE B.12. (contd)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 3 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 2 | 15 | 1 | 17 | 5 | 0 | 2 | 0 | 1 | 11 | 2 | 0 | 15 | 0 | 71 | |

TABLE B.13. Summary of Diesel Engine Failure Data, AGEATEVENT = 3, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f |  | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 1 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |

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## TABLE B.13. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

4

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

6

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

6

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LINKAGES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.13. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 1 | 9 | 2 | 22 | 7 | 2 | 8 | 0 | 0 | 5 | 0 | 0 | 7 | 0 | 63 | |

## TABLE B.14. Summary of Diesel Engine Failure Data, AGEATEVENT = 4, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - MAIN BEARINGS | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - LINERS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 7 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 5 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 6 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 5 |

## TABLE B.14. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

9

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |

4

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| - RELAYS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INSTRUMENT & CNTRL | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

4

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 7 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - RELAYS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

2

## TABLE B.14. (contd)

| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | | | | | | | | | | | | | | | | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 6 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 4 | 15 | 0 | 15 | 11 | 2 | 1 | 0 | 1 | 9 | 0 | 0 | 12 | 0 | 70 | |

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## TABLE B.15. Summary of Diesel Engine Failure Data, AGEATEVENT = 5, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 5 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - CONTROLS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.15. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 | |
| - CONTROL VALVES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 12 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - HEAT EXCHANGERS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 10 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | |
| - VOLTAGE REGULATOR | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 7 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 1 | 0 | 6 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 12 | |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - LINKAGES | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | |
| - SENSORS | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 37 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

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## TABLE B.15. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| **ELECTRICAL SYSTEMS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |
| **MISCELLANEOUS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| **UNRELATED TO EDG** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| **EDG FUNCTIONS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| **TOTAL** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 4 | 9 | 0 | 41 | 19 | 0 | 5 | 0 | 5 | 7 | 0 | 0 | 16 | 1 | 107 | |

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TABLE B.16. Summary of Diesel Engine Failure Data, AGEATEVENT = 6, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PISTONS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROLS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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## TABLE B.16. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 9 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

7

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 3 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 15 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 4 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINKAGES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - RELAYS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SENSORS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

TABLE B.16. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 5 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 4 | 13 | 1 | 30 | 21 | 0 | 5 | 0 | 3 | 8 | 0 | 0 | 16 | 1 | 102 | |

## TABLE B.17. Summary of Diesel Engine Failure Data, AGEATEVENT = 7, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

3

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

5

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |

6

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - PIPING ON ENGINE | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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## TABLE B.17. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 6 |
| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUMPS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INTERCOOLER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 9 |
| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - GENERATOR | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - VOLTAGE REGULATOR | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 6 |
| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - GOVERNOR | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL VALVES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - RELAYS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | |
| - SENSORS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 31 |
| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS.CHOCKS.ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

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TABLE B.17. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 4 | 16 | 2 | 40 | 16 | 0 | 2 | 0 | 0 | 5 | 0 | 0 | 11 | 0 | 96 | |

## TABLE B.18. Summary of Diesel Engine Failure Data, AGEATEVENT = 8, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CRANKCASE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - AIR COMPRESSOR | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROLS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

3

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.18. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 6 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - RELAYS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.18. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 2 | 9 | 2 | 12 | 11 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 6 | 0 | 57 | |

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## TABLE B.19. Summary of Diesel Engine Failure Data, AGEATEVENT = 9, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - MAIN BEARINGS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

1

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROLS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

5

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.19. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

4

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 6 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.19. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 3 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 2 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 2 | 11 | 3 | 26 | 9 | 0 | 3 | 0 | 0 | 11 | 0 | 0 | 6 | 0 | 71 | |

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TABLE B.20. Summary of Diesel Engine Failure Data, AGEATEVENT = 10, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINERS | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 4 |

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 6 |

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 8 |

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 5 |

## TABLE B.20. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - HEAT EXCHANGERS | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 4 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.20. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| + PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 2 | 11 | 0 | 15 | 7 | 1 | 3 | 0 | 2 | 5 | 0 | 0 | 8 | 0 | 54 | |

TABLE B.21. Summary of Diesel Engine Failure Data, AGEATEVENT = 11, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

1

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

## TABLE B.21. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

4

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

4

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SENSORS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |

13

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.21. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 2 | 9 | 0 | 5 | 8 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 7 | 0 | 35 | |

## TABLE B.22. Summary of Diesel Engine Failure Data, AGEATEVENT = 12, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |

## TABLE B.22. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

5

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.22. (contd)

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 2 | 4 | 1 | 4 | 6 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 5 | 0 | 25 | |

## TABLE B.23. Summary of Diesel Engine Failure Data, AGEATEVENT = 13, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.23. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

5

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.23. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 1 | 3 | 0 | 5 | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | |

## TABLE B.24. Summary of Diesel Engine Failure Data, AGEATEVENT = 14, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

## TABLE B.24. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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TABLE B.24. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 5 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 16 | |

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## TABLE B.25. Summary of Diesel Engine Failure Data, AGEATEVENT = 15, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.25. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS, CHOCKS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.25. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |

## TABLE B.26. Summary of Diesel Engine Failure Data, AGEATEVENT = 16, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.26. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.26. (contd)

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | |

TABLE B.27. Summary of Diesel Engine Failure Data, AGEATEVENT = 17, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.27. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS, CHOCKS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC . | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.27. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |

TABLE B.28. Summary of Diesel Engine Failure Data, AGEATEVENT = 18, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.28. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

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## TABLE B.28. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |

## TABLE B.29. Summary of Diesel Engine Failure Data, AGEATEVENT = 19, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.29. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.29. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

TABLE B.30. Summary of Diesel Engine Failure Data, AGEATEVENT = 20, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.30. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.30. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 |

## TABLE B.31. Summary of Diesel Engine Failure Data, Code 1 Engines, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROLS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - TURBOCHARGER | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 7 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 3 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |

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## TABLE B.31. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| - FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - CONTROL VALVES | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 2 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 9 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 7 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 6 |
| - RELAYS | 3 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 6 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 2 | 0 | 19 |
| - OVERSPEED GOVERNOR | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 3 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

2

## TABLE B.31. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROLS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 | 8 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 7 | 43 | 2 | 21 | 14 | 5 | 4 | 1 | 3 | 29 | 2 | 1 | 15 | 0 | 147 | |

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## TABLE B.32. Summary of Diesel Engine Failure Data, Code 1 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 3 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 4 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 6 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 11 |

## TABLE B.32. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

6

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |

12

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 6 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 15 |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 3 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.32. (contd)

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 1 | 17 | 2 | 17 | 13 | 1 | 1 | 1 | 1 | 11 | 1 | 0 | 12 | 0 | 78 | |

## TABLE B.33. Engine Failure Data Summary, Code 2 - All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.33. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

4

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.33. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 10 |

## TABLE B.34. Summary of Diesel Engine Failure Data, Code 2 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.34. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.34. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 7 | |

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## TABLE B.35. Summary of Diesel Engine Failure Data, Code 3 Engines, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

4

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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# TABLE B.35. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 5 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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TABLE B.35. (contd)

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 3 | 0 | 3 | 5 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 9 | 0 | 25 | |

## TABLE B.36. Summary of Diesel Engine Failure Data, Code 3 Engines All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |

TABLE B.36. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 5 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.36. (contd)

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 0 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 6 | 0 | 18 | |

## TABLE B.37. Summary of Diesel Engine Failure Data, Code 4 Engines, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LINERS | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 7 |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PISTONS | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ROCKER ARM ASSEMBLY | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 6 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 8 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 4 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 14 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.37. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FILTERS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 9 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | |
| - HEAT EXCHANGERS | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - PIPING | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 23 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 5 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - VOLTAGE REGULATOR | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 6 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - RELAYS | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 11 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 2 | 4 | 0 | 2 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 15 | |
| - OVERSPEED GOVERNOR | 0 | 3 | 0 | 3 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 11 | |
| - CONTROL VALVES | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - STARTUP SYSTEM | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 11 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 17 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - SENSORS | 0 | 4 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 73 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

## TABLE B.37. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROLS | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - OTHER | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 11 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 12 | 42 | 2 | 50 | 21 | 5 | 18 | 0 | 5 | 24 | 0 | 0 | 26 | 2 | 207 | |

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## TABLE B.38. Summary of Diesel Engine Failure Data, Code 4 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - LINERS | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 |
| **DRIVE TRAIN** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - PISTONS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| **VALVE MECHANISMS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - ROCKER ARM ASSEMBLY | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| **STARTING COMPONENTS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 10 |
| **INTAKE AND EXHAUST** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 6 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| **FUEL COMPONENTS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 3 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |

## TABLE B.38. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 6 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - PIPING | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 3 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 9 |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 6 |
| - CONTROL VALVES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 1 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 14 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 3 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 9 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS, CHOCKS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.38. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **ELECTRICAL SYSTEMS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROLS | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| **MISCELLANEOUS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **UNRELATED TO EDG** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **EDG FUNCTIONS** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| **TOTAL** | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 5 | 21 | 2 | 46 | 13 | 3 | 7 | 0 | 2 | 11 | 0 | 0 | 21 | 0 | 131 | |

## TABLE B.39. Summary of Diesel Engine Failure Data, Code 5 Engines, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CRANKCASE | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 4 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - MAIN BEARINGS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

2

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - STARTING AIR VALVE | 0 | 1 | 0 | 3 | 4 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 12 |
| - AIR COMPRESSOR | 0 | 5 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 10 |
| - CONTROLS | 1 | 2 | 0 | 2 | 7 | 0 | 2 | 0 | 1 | 7 | 0 | 0 | 6 | 2 | 30 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - STARTING MOTORS | 3 | 5 | 0 | 2 | 10 | 0 | 2 | 0 | 0 | 5 | 0 | 0 | 6 | 0 | 33 |
| - OTHER | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 6 | 12 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 2 | 30 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| - STRAINERS & FILTERS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 5 |
| - OIL STORAGE | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 |
| - PIPING ON ENGINE | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 7 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHERS | 0 | 5 | 0 | 2 | 3 | 0 | 3 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 18 |

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## TABLE B.39. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 4 | 0 | 6 | 5 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 17 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - HEAT EXCHANGERS | 0 | 4 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 12 |
| - CONTROL VALVES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 3 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 1 | 2 | 1 | 8 | 2 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 18 |
| - HEAT EXCHANGERS | 3 | 8 | 1 | 2 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 22 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 2 | 2 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 10 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| - OTHER | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 8 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 2 | 1 | 0 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 13 |
| - EXCITER | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 7 |
| - VOLTAGE REGULATOR | 1 | 5 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 14 |
| - PEDESTAL BEARINGS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 3 | 4 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 14 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 2 | 6 | 0 | 0 | 6 | 1 | 3 | 1 | 1 | 4 | 0 | 0 | 4 | 0 | 28 |
| - RELAYS | 5 | 13 | 0 | 2 | 7 | 1 | 8 | 0 | 1 | 4 | 0 | 0 | 1 | 2 | 44 |
| - INSTRUMENT & CNTRL | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 7 |
| - OTHER | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 7 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 15 | 1 | 11 | 4 | 2 | 10 | 0 | 1 | 11 | 0 | 0 | 10 | 0 | 66 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 11 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 7 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - STARTUP SYSTEM | 1 | 1 | 0 | 2 | 1 | 1 | 3 | 0 | 1 | 4 | 0 | 1 | 4 | 0 | 19 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - RELAYS | 1 | 2 | 0 | 2 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 7 | 2 | 19 |
| - SENSORS | 1 | 8 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 6 | 0 | 0 | 2 | 1 | 22 |
| - OTHER | 0 | 3 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 10 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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TABLE B.39. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 5 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | |
| - WIRING, CONDUIT, ETC | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 6 | |
| - TRANSFORMERS | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - CONTROLS | 0 | 3 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 9 | |
| - OTHER | 3 | 10 | 0 | 1 | 1 | 1 | 4 | 0 | 0 | 7 | 0 | 0 | 0 | 1 | 28 | 53 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 1 | 2 | 0 | 11 | 11 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 5 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 4 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 52 | 150 | 7 | 89 | 90 | 22 | 55 | 2 | 25 | 92 | 1 | 2 | 78 | 16 | 681 | |

## TABLE B.40. Summary of Diesel Engine Failure Data, Code 5 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - MAIN BEARINGS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - LINERS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 9 |

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 4 |

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 3 | 4 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 10 | |
| - AIR COMPRESSOR | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | |
| - CONTROLS | 1 | 1 | 0 | 2 | 6 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 2 | 1 | 18 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 2 | 0 | 2 | 10 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 20 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 56 |

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 3 | 8 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 15 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 15 |

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PIPING ON ENGINE | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 | |
| | | | | | | | | | | | | | | | | 22 |

## TABLE B.40. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 6 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 13 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 7 |
| - CONTROL VALVES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LUBE OIL | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 1 | 8 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 13 |
| - HEAT EXCHANGERS | 1 | 6 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 14 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 8 |
| - EXCITER | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 |
| - VOLTAGE REGULATOR | 0 | 4 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 10 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 6 |
| - RELAYS | 0 | 5 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 |
| - INSTRUMENT & CONTROL | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 11 | 0 | 9 | 3 | 0 | 6 | 0 | 1 | 5 | 0 | 0 | 7 | 0 | 43 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 7 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - LINKAGES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTUP SYSTEM | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 6 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - WIRING & TERMINATIONS | 0 | 1 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - RELAYS | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 12 |
| - SENSORS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 4 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.40. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROLS | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | |
| - OTHER | 0 | 5 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | |
| | | | | | | | | | | | | | | | | 17 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 2 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 15 | 62 | 4 | 76 | 68 | 2 | 17 | 0 | 5 | 26 | 0 | 0 | 56 | 2 | 333 | |

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## TABLE B.41. Summary of Diesel Engine Failure Data, Code 6 Engines, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CRANKCASE | 2 | 0 | 0 | 6 | 5 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 21 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - MAIN BEARINGS | 3 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 12 | |
| - LINERS | 3 | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 14 | |
| - OTHER | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| | | | | | | | | | | | | | | | | 55 |
| **DRIVE TRAIN** | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **m** | **n** | **TOTAL** | |
| - CRANKSHAFT | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - CONN RODS | 3 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - PISTONS | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 4 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 18 |
| **VALVE MECHANISMS** | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **m** | **n** | **TOTAL** | |
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |
| **STARTING COMPONENTS** | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **m** | **n** | **TOTAL** | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 11 | |
| - AIR COMPRESSOR | 0 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 6 | |
| - CONTROLS | 0 | 1 | 0 | 1 | 5 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 1 | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 6 | |
| | | | | | | | | | | | | | | | | 40 |
| **INTAKE AND EXHAUST** | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **m** | **n** | **TOTAL** | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 3 | 11 | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 21 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 2 | 3 | 0 | 7 | 3 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 19 | |
| | | | | | | | | | | | | | | | | 41 |
| **FUEL COMPONENTS** | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **m** | **n** | **TOTAL** | |
| - INJECTOR PUMPS | 0 | 2 | 1 | 6 | 5 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 17 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 4 | |
| - FUEL OIL PUMPS | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - OIL STORAGE | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 6 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 18 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 22 | |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 6 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 13 | |
| - FUEL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHERS | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 8 | |
| | | | | | | | | | | | | | | | | 75 |

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## TABLE B.41. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FILTERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| - STRAINERS | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 |
| - HEAT EXCHANGERS | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 6 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 8 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 5 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 8 |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INTERCOOLER | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 0 | 12 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 11 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - VOLTAGE REGULATOR | 0 | 3 | 0 | 2 | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 3 | 0 | 13 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 1 | 4 | 0 | 2 | 0 | 0 | 6 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 18 |
| - RELAYS | 1 | 11 | 2 | 0 | 4 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 24 |
| - INSTRUMENT & CNTRL | 1 | 3 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 10 |
| - OTHER | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 8 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 4 | 0 | 5 | 6 | 0 | 5 | 0 | 2 | 8 | 0 | 0 | 3 | 0 | 33 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 9 |
| - LINKAGES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - STARTUP SYSTEM | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 7 | 2 | 15 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - WIRING & TERMINATIONS | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - RELAYS | 2 | 2 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 2 | 0 | 12 |
| - SENSORS | 2 | 4 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 17 |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 8 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |

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## TABLE B.41. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 10 | 18 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 36 | 100 | 8 | 97 | 74 | 11 | 41 | 3 | 28 | 72 | 2 | 1 | 49 | 11 | 533 | |

TABLE B.42. Summary of Diesel Engine Failure Data, Code 6 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CRANKCASE | 0 | 0 | 0 | 8 | 5 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 19 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - MAIN BEARINGS | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 6 | |
| - LINERS | 3 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 10 | |
| - OTHER | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 38 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - CONNECTING RODS | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - CONTROLS | 0 | 0 | 0 | 1 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 19 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 2 | 7 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 7 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 10 | 23 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 2 | 1 | 6 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - FUEL OIL PUMPS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OIL STORAGE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 17 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 19 | |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 51 |

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## TABLE B.42. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - FILTERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| - STRAINERS | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - HEAT EXCHANGERS | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - HEAT EXCHANGERS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - INTERCOOLER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 9 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 6 |
| - RELAYS | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 4 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 2 | 0 | 5 | 5 | 0 | 3 | 0 | 1 | 4 | 0 | 0 | 2 | 0 | 22 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| - LINKAGES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - WIRING & TERMINATIONS | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - RELAYS | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| - SENSORS | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 5 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

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## TABLE B.42. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | 1 |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | 4 |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | 0 |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | 0 |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 12 | 32 | 5 | 86 | 51 | 2 | 17 | 0 | 10 | 26 | 1 | 0 | 32 | 0 | 274 | |

## TABLE B.43. Summary of Diesel Engine Failure Data, Code 7 Engines All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 3 |
| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 3 |
| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |
| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 7 |
| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - INJECTOR PUMPS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL OIL PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHERS | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 14 |

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## TABLE B.43. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 7 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 2 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - HEAT EXCHANGERS | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 4 | |
| | | | | | | | | | | | | | | | | 15 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |
| - RELAYS | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 5 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL VALVES | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - SENSORS | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 23 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

TABLE B.43. (contd)

| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - WIRING, CONDUIT, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 3 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8 | 11 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 2 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 4 | 16 | 0 | 20 | 16 | 1 | 15 | 0 | 1 | 12 | 0 | 1 | 7 | 2 | 95 | |

## TABLE B.44. Summary of Diesel Engine Failure Data, Code 7 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

2

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.44. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 2 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 8 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 1 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL VALVES | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - SENSORS | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 16 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

## TABLE B.44. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 1 | 4 | 0 | 18 | 8 | 0 | 7 | 0 | 0 | 4 | 0 | 0 | 5 | 0 | 47 | |

## TABLE B.45. Summary of Diesel Engine Failure Data, Code 8 Engines All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CRANKCASE | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ROCKER ARM ASSEMBLY | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

3

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 2 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 9 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROLS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 2 | 2 | 0 | 4 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 4 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 0 | 11 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |

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## TABLE B.45. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 6 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTERCOOLER | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | |
| | | | | | | | | | | | | | | | | 18 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - EXCITER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - VOLTAGE REGULATOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - PEDESTAL BEARINGS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 7 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INSTRUMENT & CNTRL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 7 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 14 | |
| - OVERSPEED GOVERNOR | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - LINKAGES | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | |
| - STARTUP SYSTEM | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 4 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - RELAYS | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - SENSORS | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | |
| | | | | | | | | | | | | | | | | 40 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS, CHOCKS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

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## TABLE B.45. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING, CONDUIT, ETC | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 4 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 23 | 52 | 2 | 32 | 14 | 3 | 9 | 0 | 3 | 11 | 3 | 0 | 12 | 0 | 164 | |

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## TABLE B.46. Summary of Diesel Engine Failure Data, Code 8 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CRANKCASE | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - CYLINDER BLOCK | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - ROCKER ARM ASSEMBLY | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 2 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 2 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 7 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| - INJECTORS & NOZZLES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |

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## TABLE B.46. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - RADIATOR | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - EXCITER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

4

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 5 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - LINKAGES | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - SENSORS | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

## TABLE B.46. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 14 | 40 | 2 | 28 | 11 | 2 | 6 | 0 | 1 | 7 | 2 | 0 | 6 | 0 | 119 | |

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# TABLE B.47. Summary of Diesel Engine Failure Data, Code 9 Engines All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING ON ENGINE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.47. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 4 |

| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 3 |

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - RELAYS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INSTRUMENT & CNTRL | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 4 |

| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - OVERSPEED GOVERNOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - LINKAGES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RELAYS | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - SENSORS | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 14 |

| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - RAILS,CHOCKS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

## TABLE B.47. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 3 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 3 | 15 | 0 | 11 | 6 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 5 | 0 | 49 | |

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TABLE B.48. Summary of Diesel Engine Failure Data, Code 9 Engines, All Failures, Aging and Wear Only

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - CRANKCASE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CYLINDER BLOCK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - HEADS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - MAIN BEARINGS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - LINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 2 |

| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONNECTING RODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PISTONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONN ROD BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - INTAKE & EXHAUST VALVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |

| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STARTING AIR VALVE | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | |
| - AIR COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TANKS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| - STARTING MOTORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| | | | | | | | | | | | | | | | | 5 |

| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TURBOCHARGER | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - SILENCER (MUFFLER) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 1 |

| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | |
| - STRAINERS & FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - FUEL OIL PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OIL STORAGE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING ON ENGINE | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - INJECTORS & NOZZLES | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - FUEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 5 |

## TABLE B.48. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - FILTERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - LUBE OIL | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HEAT EXCHANGERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INTERCOOLER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RADIATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - COOLING WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - EXCITER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - VOLTAGE REGULATOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PEDESTAL BEARINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0

| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - INSTRUMENT & CONTROL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OVERSPEED GOVERNOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - ALARMS AND SHUTDOWNS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - LINKAGES | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - STARTUP SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CONTROL AIR SYSTEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - WIRING & TERMINATIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RELAYS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - SENSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS, CHOCKS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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## TABLE B.48. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING AND FITTINGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PIPING SUPPORTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - SWITCHES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - TRANSFORMERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - CONTROLS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | | 0 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | k | l | m | n | TOTAL | |
| | 1 | 5 | 0 | 9 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 24 | |

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# APPENDIX C

## COMPONENT/RECOMMENDED CORRECTIVE ACTION MATRICES

## TABLE C.1. Corrective Action Data Summary, Aging and Wear Related Failures, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - CRANKCASE | 9 | 1 | 14 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 26 |
| - CYLINDER BLOCK | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 1 | 0 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| - MAIN BEARINGS | 0 | 0 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| - LINERS | 1 | 0 | 6 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| - OTHER | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - CONNECTING RODS | 0 | 0 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| - PISTONS | 0 | 0 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - INTAKE & EXHAUST VALVE | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STARTING AIR VALVE | 12 | 2 | 10 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 36 |
| - AIR COMPRESSOR | 4 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| - CONTROLS | 15 | 3 | 10 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 31 |
| - BARRING DEVICE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - STRAINERS & FILTERS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - TANKS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - STARTING MOTORS | 2 | 1 | 17 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| - OTHER | 2 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - TURBOCHARGER | 5 | 6 | 24 | 5 | 3 | 0 | 0 | 0 | 0 | 2 | 45 |
| - SILENCER (MUFFLER) | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - OTHER | 1 | 3 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 4 | 1 | 19 | 9 | 0 | 0 | 0 | 0 | 1 | 0 | 34 |
| - STRAINERS & FILTERS | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 7 |
| - FUEL OIL PUMPS | 1 | 0 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - OIL STORAGE | 2 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| - PIPING ON ENGINE | 8 | 2 | 28 | 13 | 0 | 0 | 0 | 0 | 1 | 0 | 52 |
| - INJECTORS & NOZZLES | 3 | 0 | 11 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 20 |
| - FUEL | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 4 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 10 |

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## TABLE C.1. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 3 | 0 | 13 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 18 |
| - FILTERS | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - STRAINERS | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - HEAT EXCHANGERS | 3 | 1 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| - CONTROL VALVES | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - PIPING | 1 | 0 | 5 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 10 |
| - LUBE OIL | 4 | 0 | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 12 |
| - OTHER | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 2 | 1 | 21 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 26 |
| - HEAT EXCHANGERS | 6 | 6 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 |
| - INTERCOOLER | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| - RADIATOR | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 3 | 0 | 17 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 25 |
| - COOLING WATER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 6 | 0 | 9 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 19 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 1 | 2 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| - EXCITER | 3 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| - VOLTAGE REGULATOR | 5 | 0 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| - PEDESTAL BEARINGS | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| - OTHER | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 10 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 |
| - RELAYS | 4 | 0 | 7 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| - INSTRUMENT & CONTROL | 2 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| - OTHER | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 7 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 44 | 3 | 52 | 4 | 1 | 0 | 0 | 0 | 5 | 0 | 109 |
| - OVERSPEED GOVERNOR | 11 | 1 | 6 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 20 |
| - CONTROL VALVES | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - ALARMS AND SHUTDOWNS | 10 | 1 | 10 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| - LINKAGES | 7 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 15 |
| - STARTUP SYSTEM | 6 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| - CONTROL AIR SYSTEM | 6 | 1 | 16 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 26 |
| - WIRING & TERMINATIONS | 12 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 19 |
| - RELAYS | 9 | 0 | 11 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 26 |
| - SENSORS | 12 | 0 | 14 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 29 |
| - OTHER | 3 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - RAILS, CHOCKS, ETC | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - DRAINAGE OF WASTE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

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## TABLE C.1. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - PIPING SUPPORTS | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | 4 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - SWITCHES | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - WIRING,CONDUIT,ETC | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | |
| - TRANSFORMERS | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| - CONTROLS | 2 | 1 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | |
| - OTHER | 0 | 0 | 10 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | |
| | | | | | | | | | | | | 32 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | | 1 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 3 | 3 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | |
| | | | | | | | | | | | | 12 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - PROCEDURES, PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, CM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - PROCEDURES, SURV. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| | 279 | 51 | 552 | 134 | 15 | 1 | 3 | 2 | 19 | 7 | 1063 | |

## TABLE C.2. Corrective Action Data Summary, Entire Diesel Database, All Failures

| ENGINE STRUCTURE | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - BASE | 0 | 0 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 6 |
| - CRANKCASE | 9 | 2 | 14 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 29 |
| - CYLINDER BLOCK | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HEADS | 3 | 1 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| - MAIN BEARINGS | 0 | 1 | 12 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| - LINERS | 1 | 0 | 12 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| - OTHER | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 6 |

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| DRIVE TRAIN | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - CRANKSHAFT | 0 | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| - CONNECTING RODS | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| - PISTONS | 0 | 2 | 10 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| - GEAR CAMSHAFT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - CAMSHAFT | 0 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| - FYLWHEEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| - CONN ROD BEARINGS | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - OTHER | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

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| VALVE MECHANISMS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUSHRODS | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - ROCKER ARM ASSEMBLY | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - INTAKE & EXHAUST VALVE | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - OTHER | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

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| STARTING COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - STARTING AIR DIST | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - STARTING AIR VALVE | 17 | 3 | 12 | 13 | 0 | 1 | 0 | 0 | 0 | 0 | 46 |
| - AIR COMPRESSOR | 8 | 2 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| - CONTROLS | 27 | 3 | 15 | 2 | 2 | 2 | 0 | 0 | 0 | 4 | 55 |
| - BARRING DEVICE | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - STRAINERS & FILTERS | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - TANKS | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 |
| - STARTING MOTORS | 6 | 5 | 24 | 7 | 0 | 1 | 1 | 0 | 1 | 1 | 46 |
| - OTHER | 5 | 1 | 7 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 16 |

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| INTAKE AND EXHAUST | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - AIR FILTER | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| - TURBOCHARGER | 11 | 10 | 36 | 11 | 6 | 2 | 1 | 0 | 0 | 2 | 79 |
| - SILENCER (MUFFLER) | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| - OTHER | 4 | 5 | 15 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 29 |

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| FUEL COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - INJECTOR PUMPS | 11 | 1 | 23 | 9 | 0 | 0 | 0 | 0 | 1 | 0 | 45 |
| - STRAINERS & FILTERS | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 11 |
| - FUEL OIL PUMPS | 4 | 0 | 7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| - OIL STORAGE | 5 | 1 | 6 | 1 | 3 | 0 | 0 | 2 | 0 | 0 | 18 |
| - PIPING ON ENGINE | 12 | 4 | 31 | 13 | 0 | 0 | 0 | 0 | 1 | 0 | 61 |
| - INJECTORS & NOZZLES | 4 | 0 | 11 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 21 |
| - FUEL | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| - OTHER | 17 | 2 | 8 | 4 | 0 | 1 | 3 | 0 | 1 | 0 | 36 |

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## TABLE C.2. (contd)

| LUBRICATION COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 6 | 0 | 15 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 27 |
| - FILTERS | 3 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| - STRAINERS | 7 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - HEAT EXCHANGERS | 3 | 3 | 21 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 28 |
| - CONTROL VALVES | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| - PIPING | 1 | 0 | 6 | 2 | 3 | 0 | 0 | 1 | 0 | 0 | 13 |
| - LUBE OIL | 5 | 0 | 10 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 19 |
| - OTHER | 7 | 0 | 5 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 14 |

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| COOLING COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - PUMPS | 6 | 5 | 26 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 43 |
| - HEAT EXCHANGERS | 6 | 8 | 12 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 32 |
| - INTERCOOLER | 1 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - RADIATOR | 6 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 12 |
| - COOLING TOWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - PIPING | 7 | 0 | 19 | 2 | 4 | 0 | 0 | 1 | 0 | 0 | 33 |
| - COOLING WATER | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| - OTHER | 15 | 3 | 11 | 6 | 1 | 0 | 1 | 0 | 1 | 1 | 39 |

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| GENERATOR COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - GENERATOR | 3 | 2 | 14 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 27 |
| - EXCITER | 3 | 1 | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| - VOLTAGE REGULATOR | 10 | 1 | 18 | 3 | 0 | 0 | 1 | 2 | 0 | 1 | 36 |
| - PEDESTAL BEARINGS | 1 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 |
| - OTHER | 5 | 1 | 4 | 7 | 2 | 0 | 2 | 0 | 0 | 0 | 21 |

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| SWITCHGEAR COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - BREAKERS | 26 | 8 | 10 | 10 | 4 | 1 | 0 | 3 | 0 | 2 | 64 |
| - RELAYS | 32 | 8 | 12 | 22 | 7 | 6 | 2 | 0 | 0 | 0 | 89 |
| - INSTRUMENT & CONTROL | 5 | 0 | 11 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 22 |
| - OTHER | 5 | 1 | 10 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 18 |

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| INSTRUMENTS AND CONTROLS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - GOVERNOR | 69 | 4 | 60 | 14 | 3 | 2 | 1 | 2 | 7 | 1 | 163 |
| - OVERSPEED GOVERNOR | 22 | 3 | 9 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 39 |
| - CONTROL VALVES | 5 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| - ALARMS AND SHUTDOWNS | 15 | 1 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 34 |
| - LINKAGES | 9 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 17 |
| - STARTUP SYSTEM | 16 | 0 | 10 | 3 | 2 | 1 | 1 | 3 | 0 | 8 | 44 |
| - CONTROL AIR SYSTEM | 7 | 1 | 16 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 29 |
| - WIRING & TERMINATIONS | 12 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 19 |
| - RELAYS | 21 | 0 | 13 | 10 | 2 | 0 | 1 | 1 | 0 | 0 | 48 |
| - SENSORS | 34 | 5 | 21 | 6 | 2 | 0 | 1 | 0 | 0 | 0 | 69 |
| - OTHER | 7 | 1 | 13 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 27 |

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| STRUCTURAL COMPONENTS | a | b | c | d | e | f | g | h | i | j | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - ENGINE FOUNDATION | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| - RAILS,CHOCKS,ETC | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - HVAC | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - DRAINAGE OF WASTE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| - OTHER | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

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## TABLE C.2. (contd)

| MECHANICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - VALVES | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| - PIPING AND FITTINGS | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | |
| - PIPING SUPPORTS | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 6 | |
| - OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | |
| | | | | | | | | | | | | 12 |
| ELECTRICAL SYSTEMS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - SWITCHES | 0 | 1 | 0 | 11 | 0 | 0 | 1 | 0 | 0 | 0 | 13 | |
| - WIRING,CONDUIT,ETC | 2 | 1 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 9 | |
| - TRANSFORMERS | 4 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | |
| - CONTROLS | 3 | 2 | 12 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 22 | |
| - OTHER | 21 | 1 | 26 | 6 | 2 | 1 | 0 | 1 | 0 | 0 | 58 | |
| | | | | | | | | | | | | 113 |
| MISCELLANEOUS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - PLATFORMS, ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | |
| | | | | | | | | | | | | 3 |
| UNRELATED TO EDG | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - MANUAL SHUTDOWN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| - OTHER | 6 | 5 | 10 | 0 | 1 | 0 | 0 | 4 | 1 | 4 | 31 | |
| | | | | | | | | | | | | 31 |
| EDG FUNCTIONS | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| - PROCEDURES, PM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | |
| - PROCEDURES, CM | 4 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 9 | |
| - PROCEDURES, SURV. | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 3 | 0 | 0 | 6 | |
| - OTHER | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 1 | 7 | |
| TOTAL | a | b | c | d | e | f | g | h | i | j | TOTAL | |
| | 600 | 125 | 766 | 272 | 72 | 27 | 27 | 34 | 27 | 34 | 1984 | |

# APPENDIX D

# RESUMES OF CONSULTANTS

JACK E. HORNER

SEAWORTHY SYSTEMS, INC.
28 Main Street
Essex, Connecticut 06426
(203) 767-9037

TITLE: Senior Engineer

## EDUCATION

University of Bridgeport - BSME 1963 - Major: Mechanical Engineering
Minor: Metallurgy

## PROFESSIONAL EXPERIENCE

1975 to present: Seaworthy Systems, Inc.

Manager - Engine and Component Analysis: Investigation of diesel engine performance, combustion problems and evaluation of failed and inservice parts: Colt Pielstick, Enterprise, M.A.N., Sulzer, B. & W., Caterpillar, Elliot, EMD. Investigation and analysis of the application of ceramic coatings on diesel engine components.

Manager, Marine Design: System development and design for shipboard fuel treatment piping and fluids handling, inclusive of power distribution, controls and instrumentation and the start-up and test of these systems. Applications have included gas turbine, boiler and diesel propulsion systems in the 5,000 to 50,000 HP range and the associated auxiliary equipment. Conducted field surveys/performance analysis on medium and slow speed diesels. Project Engineer for Maritime Administration contracts concerned with application of emulsified blended fuels for medium speed diesels, and a synopsis of foreign diesel propulsion system automation and control requirements and regulations. Project Engineer for the investigation and analysis of hydraulic cargo pumping system failures.

1974 to 1975: United Technologies/Power Utility Division

Senior Test Engineer: Responsibilities involved the basic design, procurement, test and installation of fuel cell components and systems. fuel cell development and application of high power, high density basic cells for military/aerospace applications and high power acid cells for utility base load applications.

1973 to 1974: Northeast Utilities - Nuclear Construction

Resident Mechanical Engineer: On-site liaison between Northeast Utilities engineering and outside contractors. Supervision of mechanical and electrical planning, installation and system turnover of major and minor nuclear and non-nuclear power plant systems.

1969 to 1973: United Aircraft - Turbo Power and Marine Systems

Applications Engineer: Assignment involved the application, installation and test of gas turbine powered marine and electrical power generation systems in singular and multi-engine arrangements rated to 120,000 HP. Typical applications have involved domestic and foreign electrical generating stations; U.S. and foreign military vessels and commercial cargo carriers.

Additional responsibilities have included being the resident engineer at the prime vendor's plant to institute and establish an acceptance and testing program for electrical power generating control houses and generators rated to 50 MW. Project Engineer in Japan for the acceptance and testing of controls and equipment for multi-engined electrical power generation (25 MW and 50 MW) sites in Mexico.

1967 to 1969: General Dynamics - Quincy Division

Systems Engineer: Project/concept formulation/systems engineering for advanced naval ships; propulsion and auxiliary machinery.

1963 to 1967: General Dynamics - Electric Boat Division

Research Engineer: Nondestructive testing research and development of metallics and nonmetallics; determination of physical properties and defects found in raw materials and occurrences in joining processes. Typical studies involved ultrasonic measurements, eddy current, magnetic particle, x-ray and conductivity detection and brazing of ferrous and nonferrous metals. Developed mechanical, electromechanical and automatic testing mechanisms for welded and brazed joints.

Advanced engineering and studies of surface and subsurface vehicles, manned and unmanned submersibles, underwater stations, platforms and power plants.

## ASSOCIATIONS

Institution of Diesel & Gas Turbine Engineers, London

Society of Automotive Engineers - Marine Propulsion Committee

American Society of Mechanical Engineers - Internal Combustion Engines Division

Instrument Society of America

Institute of Electronic and Electrical Engineers

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## PUBLICATIONS

J. E. Horner, P. J. Vollemans, T. J. Pakula, "An Assessment of Automation and Control Systems Requirements of Foreign Marine Diesel Propulsion Systems, Final Report," Maritime Administration, Report No. MA-RD-920-81042.

J. E. Horner, "Evaluation of Techniques for Improving Combustion Aboard Ships - Medium Speed Diesel Engines (Intermediate Grade Fuels)," Maritime Administration, Report No. MA-RD-920-80004.

## B. J. KIRKWOOD, P.E.

?

Covenant Engineering
PO Box 788 Buena Vista, CO 81211
303/396-6056

Registered Professional Engineer - CO, MO, KS, IA (inactive)

Massachusetts Institute of Technology - 1950 - BS/Mechanical Engineering
- 1950 - MS/Econ & Engrg.

Member: American Society of Mechanical Engineers
- Associate - Diesel and Gas Engine Power Div (+ 2 others)
- Secretary (1967-73) Performance Test Code Com. #17, Reciprocating Internal Combustion Engines

Accreditation Board for Engineering and Technology (ME)
American Solar Energy Society
National Society of Professional Engineers
Colorado Engineering Society (ex - MoSPE and KsES)
Pi Tau Sigma (national honorary ME fraternity)

1984 - present - Covenant Engineering - Self-employed consulting engineer (semi-retired)

Services include studies and consultation on: power supply planning; utility rates and economics; diesel engine applications; project administration and financing; utility coordination; etc. Recent and present clients include: Kansas Municipal Energy Agency (retained for both general and specific consultation projects); Pacific Northwest Laboratory (consultation re: nuclear standby engines in a project for the Nuclear Regulatory Comn); and the City of Ottawa, KS, through A. C. Kirkwood & Assocs (utility rate study).

1982 - 1984 - B. J. Kirkwood, PE, Consulting Engineer (4308 W 79th Prairie Village, KS 66208) - Self-employed consulting engineer (semi-retired)

Services were the same as for Covenant Engineering. The only client was A. C. Kirkwood & Assocs, on projects involving utility rate studies for several clients, investigation of power supply proposals for a group of clients, and preparation of PURPA regulations for several local systems.

1954 - 1982 - A. C. Kirkwood & Assocs. (8080 Ward Parkway, Kansas City, MO 64114)

(A consulting engineering firm with a staff of generally 35-40, doing municipal, industrial and other governmental work in the fields of power, water, sewage, gas rates, feasibility studies, energy analyses, etc.)

Retired 1/1/82 as one of the three senior partners. Responsible for quality assurance and procedure for all specifications, studies and reports; directed all and performed many economic and rate studies; project sponsor for majority of engine-generator project designs; director of long-range planning and business analyses for Firm.

Until 1977 was Director of Administration, Participated in Client Relations, Business Development and various professional and technical matters.

> NB: ACK&A was responsible (1947-1982) for probably more engine-generator installation designs than any other firm in the mid-states (the heart of smaller municipal and REC utilities), embracing at least 13 basic models of seven engine manufacturers, ranging in size from 600 to 7000 kW, and speeds of 200 to 900 rpm. BJK was responsible for 15 diesel projects for 10 different clients involving 19 engines of 5 different makes. Also directed study of present and future engine utilization for the Electric Power Research Institute.

1950 - 1954 - R. R. Donnelley & Sons (Chicago) - printers - industrial engineer; purchasing agent

Publications, etc. - Several articles for Diesel and Gas Turbine Progress magazine; papers and presentations for Energy Technology Conference, Diesel Engine Manufacturers Association, Kansas Municipal Utilities, and Iowa Association of Municipal Utilities

# PAUL J. LOUZECKY

Telephone:
Home 313/853-3992

476 Sarsfield Drive
Rochester Hills, MI 48063

## EXPERIENCE

JUNE 1970--DETROIT DIESEL ENGINE DIVISION, GENERAL MOTORS CORPORATION,
JUNE 1975 DETROIT, MICHIGAN

| | |
|---|---|
| May 1974-May 1975 | Worked on the design and development of an 8-cylinder, vee, 4-cycle diesel truck engine, both naturally aspirated and turbocharged. Did much of the analytical and vibration design work on this engine. |
| Feb. 1974-May 1974 | Designed a high-pressure, high-speed fuel injection pump for use on a rotary combustion diesel engine. Each pump plunger was designed to deliver fuel 4000 times per minute. |
| Mar. 1973-Feb. 1974 | On loan to the Engineering Staff of General Motors Corporation to design and develop a stratified-charge automotive gasoline engine. The engine had better specific fuel consumption and lower emissions than the Honda CVCC engine. |
| Jan. 1971-Mar. 1973 | Supervisor in charge of the engineering and design of three rotary combustion diesel engines. Also assisted on the design and development of the rotary combustion gasoline engine. |
| Jun. 1970-Jan. 1971 | Executive Engineer on the MBT-70 Main Battle Tank Program reporting to the Chief Engineer. My work consisted of solving a number of vehicle-related problems, such as correcting the large number of engine (power plant) problems including cylinder block cracking, piston scuffing, engine and power plant torsional vibrations; vehicle track and wheel problems; silencer, fuel tank and gun mount vibrations; and wheel and track problems. My work also included vehicle performance and evaluation studies. |

JULY 1963--RESEARCH LABORATORIES, GENERAL MOTORS CORPORATION,
JULY 1970 WARREN, MICHIGAN

Supervisory Research Engineer in the Mechanical Research and Special Projects Departments. In this capacity, I conducted work on a number of very interesting projects which included: new, very compact locomotive engines, thermal energy storage automobile with Stirling engine (emissions free), thermal energy storage submarine engine (Stirling engine), continuous casting machine for casting many metals including steel, transportation studies, very high speed transportation systems, and fuel injection studies.

JUNE 1963--WAUKESHA BEARING COMPANY, WAUKESHA, WISCONSIN
JULY 1963

Consulting Engineer; made a market study on the potential market for internal combustion engine bearings.

MAY 1958--NORDBERG MANUFACTURING COMPANY, MILWAUKEE, WISCONSIN
JUNE 1963

Chief Engineer, Engineering, Installation and Service Departments of the Engine Division. In charge of the engineering and the administrative operation of these departments, which included all design, research, development and testing of new engines as well as improving all production two-cycle and four-cycle diesel, DUAFUEL, TRIFUEL, spark-ignition, and propane engines, both naturally aspirated and turbocharged. The work also included all installation, service and customer contact work related to these responsibilities. Supervised about 250 people.

APRIL 1935--CLEVELAND DIESEL ENGINE DIVISION, GENERAL MOTORS
MAY 1958 CORPORATION, CLEVELAND, OHIO

1955-1958 Chief Technical Engineer in Charge of Analytical Design, Vibration, Instrumentation, Engineering Welding Design, Metallurgy, Chemical Laboratory, Instruction Books, and Research and Development Sections. Supervised about 100 people.

1951-1955 Head of Analytical Design Section and Special Problems Section. Worked on the design of over fifty different types of internal combustion engines.

1947-1951 Supervisor of Special Problems Section. One interesting problem was the design and development of a submarine engine to run under water with a closed-loop intake and exhaust system.

1937-1947 Head of Analytical Design Section. Responsible for all stress analysis work on engine design, vibrations, governing, engine performance and electrical power plant systems.

1935-1937

Assistant in Analytical Design Section, in charge of all engine stress analysis and related work regarding the designing and development of all types of internal combustion engines and related power plant installation problems.

JAN. 1934--WEATHERHEAD COMPANY, CLEVELAND, OHIO
APRIL 1935

Assistant in Research Laboratory: developed new hydraulic equipment, very high pressure flexible hose, and automotive and aircraft fittings; hydraulic and related automotive hardware and accessories. Also developed the copper brazing technology.

JULY 1933--ELECTRIC PRODUCTS COMPANY, CLEVELAND, OHIO
JAN. 1934

Assistant Chief Draftsman: designed and developed a considerable number of specialized electrical generators, platers, welders, switchboards, motors, and other electrical machinery.

## EDUCATION

1933 M.S. Mechanical Engineering, Case Western Reserve University, Cleveland, Ohio. Graduate Thesis: "Dynamic Flow Characteristics of Molten Lead:

1932 B.S. Mechanical Engineering, Case Western Reserve University

## PROFESSIONAL AND TECHNICAL SOCIETY MEMBERSHIP

Registered Professional Engineer, State of Ohio (E-003068); American Society of Mechanical Engineers; Society of Automotive Engineers; Sigma Xi Honorary Science Fraternity.

## TECHNICAL SOCIETY PAPERS

"Burning of Heavy Fuel in a Medium Speed, High B.M.E.P. Engine," American Society of Mechanical Engineers Paper No. 63-OGP-13, presented at O.G.P. Meeting in St. Louis, Missouri, May 19-23, 1963.

"Vibrations in River Towboats," Society of Automotive Engineers, Paper No. 699A, presented at Marine Propulsion Meeting, May 14-15, 1963, St. Louis, Missouri.

"Design and Development of a Two-Cycle Turbocharged Diesel Engine," American Society of Mechanical Engineers Paper No. 56-A-100, presented at the ASME Annual Meeting, New York, N.Y., November 25-30, 1956. Received award for Best ASME-OGP Paper presented in 1956.

## PATENTS

U.S. Patent No. 2,728,331, "Engine Lubrication and Piston Cooling," December 27, 1955.

U.S. Patent No. 3,177,997, "Electric Clutch and Automatic Starting for Engines," April 15, 1965.

U.S. Patent No. 3,800,179, "Self-Cleaning Spark Plug," March 26, 1974.

U.S. Patent No. 3,861,837, "Liquid Cooled Rotor Housing," January 21, 1975.

U.S. Patent No. 3,877,852, "Rotary Engine Drain Pump Arrangement," April 15, 1975.

March 1974, Pending: "Rotary Machine Apex Seal."

May 1974, Pending: "Split Phasing Gear for a Multi Rotor, Rotary Combustion Engine."

September 1974, Pending: "Rotary Combustion Engine Damped Apex Seal."

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12 SUPPLEMENTARY NOTES

13 ABSTRACT (200 words or less)

Pacific Northwest Laboratory evaluated operational and expert experience pertaining to the aging degradation of diesel generators in nuclear service. The research, sponsored by the U.S. Nuclear Regulatory Commission, identified and characterized the contribution of aging to emergency diesel generator failures. Volume 1 reviews diesel generator experience to identify the systems and components most subject to aging degradation and isolates the major causes of failure that may affect future operational readiness. Evaluations show that as plants age, the percent of aging-related failures increases and failure modes change. A compilation is presented of recommended corrective actions for the failures identified. A review of current relevant industry programs, research, and standards is included. Volume 2 reports results of an industry-wide workshop.

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